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PUBLICATIONS OF THE DIVISION OF VEGETABLE PATHOLOGY.

The Division of Vegetable Pathology, formerly a Section of the Botanical Division, has become a separate organization by act of Congress. Its bulletins will henceforth be numbered independently and in a new series; but the following list contains all publications issued since its organization as a Section, together with Bulletin 1 of the new series.

Bulletins and circulars still on hand for distribution are designated by an asterisk (*). Bulletins 1, 3, 4, and 6, omitted from the list, are publications of the Division of Botany, not relating to vegetable pathology.

JOURNALS.

Journal of Mycology, Vol. 5, Nos. 1, 2, 3, and 4. 1889-'90, pp. 249, pl. 14.
Journal of Mycology, Vol. 6, Nos. 1, 2,* 3,* and 4*. 1890-'91, pp. 207, pl. 18.

BULLETINS.

No. 2. Fungous Diseases of the Grape. 1886, pp. 136, pl. 7.
No. 5. Report on the Experiments made in 1887 in the Treatment of Downy Mildew and Black Rot of the Grape. 1888, pp. 113.
No. 7. Black Rot. 1888, pp. 29, pl. 1.
No. 8. A Record of Some of the Work of the Division. 1889, pp. 69.
No. 9. Peach Yellows. 1889, pp. 254, pl. 36.
No. 10. Report on the Experiments made in 1888 in the Treatment of Downy Mildew and Black Rot of the Grape, pp. 61
No. 11.* Report on the Experiments made in 1889 in the Treatment of Fungous Diseases of Plants. 1890, pp. 119.
Farmers' Bulletin No. 4.* Fungous Diseases of the Grape and their Treatment. 1891, pp. 12.
No. 1.* Additional Evidence on the Communicability of Peach Yellows and Peach Rosette. 1891, pp. 65, pl. 39.

CIRCULARS.

No. 1. Treatment of Downy Mildew and Black Rot of the Grape. 1885, pp. 3.
No. 2. Grape Vine Mildew and Black Rot. 1885, pp. 3.
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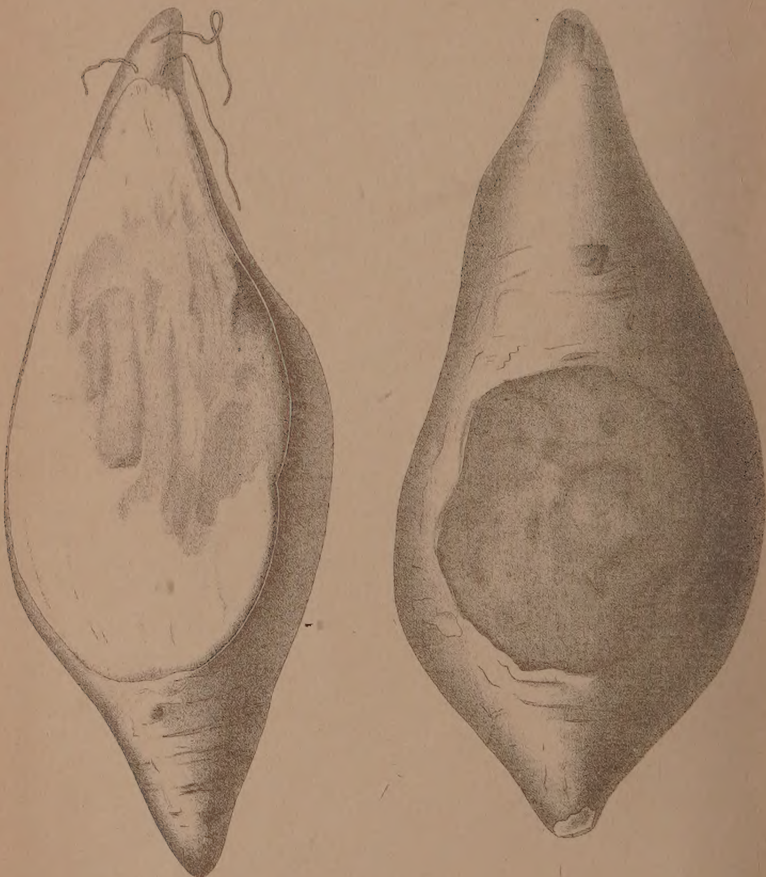

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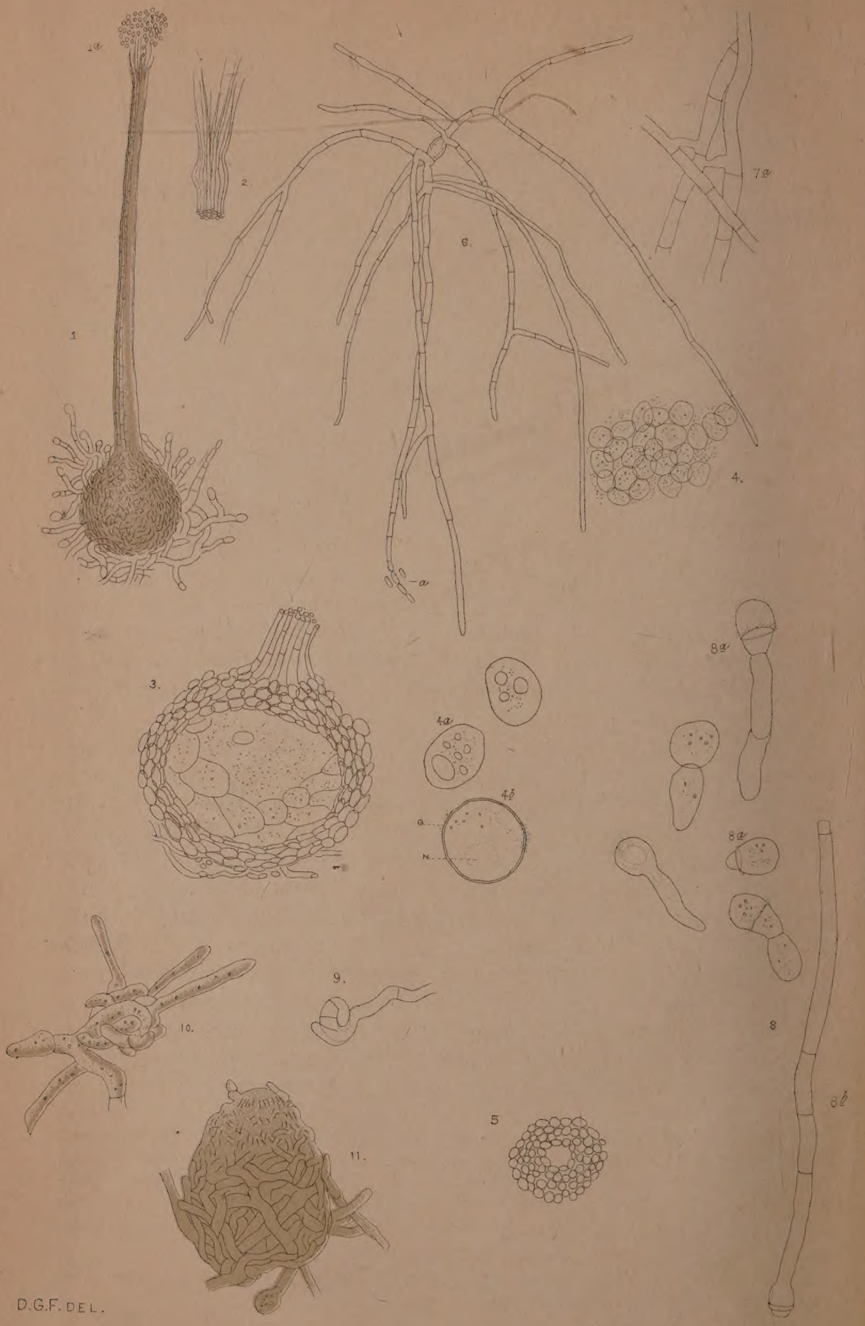

HALSTED AND FAIRCHILD ON SWEET POTATO BLACK ROT.

VOLUME VII. No. I. } JOURNAL OF MYCOLOGY. { ISSUED Sept. 10, 1891.

SWEET-POTATO BLACK ROT.

(*Ceratocystis fimbriata*, Ell. & Hals.)

By B. D. HALSTED and D. G. FAIRCHILD.*

(Plates I—III.)

There are several fungous diseases of the sweet potato known under the general term of rots,† but none of them have equaled in destructiveness the one here to be considered, namely, the black rot. It is by no means a new trouble, for many persons who have grown sweet potatoes for fifty years state that they have known of it from boyhood. The common testimony is, however, that it has increased gradually from year to year, until now in some parts of the country the disease is so bad as to be alarming.

In order to obtain definite data as to the prevalence of the black rot in New Jersey, one of the leading sweet potato growing States, a special bulletin of questions was sent to several hundred of the leading growers. From the replies it was evident that in nearly all portions of the State where sweet potatoes were grown they had been troubled with the black rot. Portions of Maryland and Delaware and the large sweet-potato region of Virginia have also more or less of the disease; in fact, so far as our observation goes, no region is entirely exempt. The exact geographical limits of the disease, however, have not been fixed, and whether or not it is strictly American remains to be ascertained.

The chief damage is seen after some months of storage, when the decay spreads rapidly from root to root, sometimes destroying as much as 25 to 30 per cent of the entire crop. Although no accurate data

* Both Mr. Fairchild and Dr. Halsted having done considerable independent work on sweet-potato diseases, it was thought best to combine their results. With this end in view, Mr. Fairchild spent some time in Dr. Halsted's laboratory in New Brunswick, N. J., where the work done in the Department by Mr. Fairchild and in the former place by Dr. Halsted was carefully compared and carried to more complete results. This paper represents a portion of the work.—[B. T. G.]

† Some Fungous Diseases of the Sweet Potato, Bulletin 76, N. J. Experiment Station, November 28, 1890, pp. 32, figures 19.

could be gathered in regard to the loss from this disease in distinction from the many other rots, 25 per cent is a low estimate for such seasons as that just passed. The rot in question, which, as is usual with fungous diseases, has been ascribed to wet weather, is caused by an interesting species of fungus; but until the authors took the matter into consideration little was known as to the real cause of the malady, and the fact of its fungous origin, while surmised, was not fully established.

EXTERNAL APPEARANCE.

The most conspicuous sign of the disease, and the one which distinguishes it from other diseases, occurs upon the potatoes themselves. It consists in the presence of dark, somewhat greenish spots, varying from a quarter of an inch to 4 inches in diameter, sometimes covering the greater part of the root and extending some distance into the tissue. These spots when once seen can not be mistaken, as they are simply sunken areas with distinct margins, like spots burned into the potato with a metal dye which has left the skin uninjured. Should the slightest doubt as to the identity of the disease remain after a superficial examination, the removal of a small portion of the skin exposing the olive-green tissue below would dispel it. Among the sprouts, or young plants grown in hotbeds, the disease manifests itself in dark lines upon the lower portion of the shoot and sometimes of the lower leaves, giving rise to the name of "black shank" among the growers. These dark lines or blotches often appear upon etiolated portions of the stem and are almost black in color. In very severe cases the tip of the sprout wilts and dies. No appearance in the field has so far been observed that would distinguish hills diseased with black rot from those attacked by some other of the numerous rots; but the dark sunken areas on the potato and the black discolorations of the sprouts can scarcely be confused with any other sweet-potato disease.

CHARACTERISTICS OF THE DISEASE.

A microscopic examination of the discolored tissue in the root reveals the fact that the starch-bearing cells have been greatly altered, the healthy portions are characterized by thin-walled cells completely packed with starch, but these have been replaced in the diseased areas by thick-walled, olive-brown ones totally deprived of starch. The thickening of the walls, seen so strikingly upon examination, is due in part to granular incrustations which often assume the form of rounded protuberances. Whether this incrusting matter is anything more than the remains of the protoplasmic contents of the cell, was not determined, but from its irregular appearance this was the natural inference.

Filling the intercellular spaces and often ramifying through the adjoining cells, are the thick-walled, olive-brown hyphæ of the parasite, and the dark color of the diseased portions is due in a measure to them.

While nothing of the nature of haustoria was observed, it was plainly evident that the presence of this abundant mycelium was the cause of the disease, for wherever the threads of the fungus reached, there were darkened cell walls and lifeless contents. No fungous ferment was observed, and it is probable that as with the *Hymenomycetes* described by Hartig* as attacking forest trees, none exists except at a very limited distance from the tips of the hyphæ.

In the intercellular spaces, and often in the cells themselves are found numerous olive bodies, which for want of a better name we have called *olive conidia*. These olive conidia are most abundant in old specimens where the decay has progressed well into the potato, and although occasionally almost wanting, are generally easily observable. Where present in large quantities they give a decided greenish brown tint to the tissue.

Upon the exterior of the diseased area are often found, though sometimes in limited numbers, together with an occasional olive conidium, delicate hyaline spores borne on aërial hyphæ. So far the hyaline spores have not been seen in progress of formation within the tissue of the potato, but upon the blackened sprouts as they are grown in the hotbed they are present in abundance, arising from the tips of elongated hyphæ.

A third form of the fungus shows itself both upon sprout and root in the shape of flask-like pycnidia with elongated beaks or necks fimbriated at the apex. Often the globular bodies of the pycnidia are buried in the tissue of the potato, and only the slender necks are visible above the surface, giving it a bristly appearance.

Where specimens covered with pycnidia are protected from the rains the pycnospores collect in a more or less firmly united mass at the apex of the neck, and the fimbriations seem to serve the purpose of a basket for the mass. The appearance of the fimbriated slender necks and surmounting yellow globules is very characteristic.

Although not certainly connected with the species of fungus causing the black rot there have been found, often in badly diseased specimens, immense numbers of globular sclerotia differing in structure from those of many other species but surrounded by and evidently made up of hyphæ identical with those of this species. These sclerotia were found in all stages of formation and in the last stages in such abundance as to entirely fill the tissue of the diseased potato, causing it to become gray and finally charcoal black.

DESCRIPTION OF CULTURES.

The growth of this parasite upon underground stems composed largely of carbohydrates suggested the idea of cultivating it upon artificial media. In doing this, numerous points of interest were brought

* Die Zersetzungserscheinungen des Holzes 1878, Berlin, Die Lehrbuch der Baumkrankheiten.

out and the structure and development of the fungus were much more easily studied than on the host itself.

A medium composed of a 1 per cent solution of agar-agar in sweet potato broth was the most satisfactory. This was made by adding to 4 grams of agar steeped for 5 hours in 300 cubic centimetres of water 100 cubic centimetres of sweet potato broth. The sweet potato broth was not essentially different from ordinary potato broth, and was made by steeping the slices from one large potato for several hours in enough water to cover them. This medium was used both in the form of plate and slanting test-tube cultures, but proved most satisfactory in the latter on account of the ease with which the tubes were handled.

Besides the sweet potato agar upon which the main study of the fungus was made, several other media were tried. Slices of sweet potato cooked and uncooked in test tubes, similar slices of Irish potato, and *nahrlosung* agar made by adding 2 grams of agar to 200 cubic centimetres of a strong decoction of fresh horse dung, were used, but showed no special points of interest. Ordinary potato broth proved entirely successful and did not reveal the presence, in this species, of sprouting or yeast forms. The fact that sections of the white pine taken from living trees and first sterilized in test tubes by intermittent boiling, grew the parasite in profusion is at least suggestive. Sections from the willow similarly treated failed to nourish the fungus.

Because of the difficulty of obtaining conidia of the fungus with which to start the growth in the hardened culture media the inoculations of sterile media were started from the mycelium itself. Small particles of the diseased tissue were carefully removed with a glass hook from the border line between the healthy and diseased portions of the potato, and sufficiently deep beneath the surface of the skin to render contamination improbable. These particles were at once inserted into the media and almost without exception produced a pure growth of the fungus. Around portions of tissue thus inserted appear in 24 hours the radiating mycelial hyphæ, and in a few days the first form of conidia. After the appearance of the first or hyaline conidia upon the surface of the culture, inoculations with the pure spores were at once made upon the various media above referred to. The cultures grew with great rapidity and maintained their vitality for months. Inoculations made on May 26 from tubes started March 18 show the pycnospores to be still alive.

Van Tieghem cells and hanging drop cultures were employed to ascertain a number of the details of growth and by the use of sweet potato agar in hanging drops on the under side of cover glasses, the growth of certain pycnidia was satisfactorily followed from day to day.

Three days after sowing pure conidia upon sweet potato agar an abundant thallus is formed which has a number of characteristic features.

Mycelium.—The hyphæ rapidly penetrate the artificial substratum, giving it a dark appearance by their presence. They are 2 – 6 μ in diameter, with frequent septa, and filled with oil globules, which give them a guttulate appearance. The globules are present in such quantities that they issue from the broken hyphæ tips under the cover glass and rise to the surface in large numbers. They give the characteristic reaction with osmic acid, are present in natural as well as artificial media, and seem to be more abundant and of larger size in half starved portions than in rapidly growing parts, as noticed by Naegeli * and Cunningham † in various species of fungi.

Simultaneously with the downward growth of the hyphæ into the substratum there rise to the surface specialized branches, which perform the office of sporophores. These long, multiseptate branches, which we may term the primary sporophores, are 60–160μ long by 6–7μ in greatest diameter, generally somewhat fusiform in shape, and with the exception of the lighter colored tips, which reach the surface of the medium, are of the greenish brown color of the remainder of the thallus.

Hyaline, or microconidia.—From the slightly colored tips of these sporophores hyaline conidia are produced immediately after they arrive at the surface of the substratum. These hyaline conidia correspond in a measure to the micro-conidia of *Nectria* and *Hyphomyces*, but owing to the impropriety in the use of the term pointed out by Reinke and Berthold,‡ the term hyaline will be used to avoid ambiguity.

The method of spore formation by which these conidia are produced resembles quite closely that observed by Unger § in the case of *Graphium penicilloides*, Corda, now called *Chalara Ungeri*, Sacc., and in a less degree that of the new genus *Endoconidium* recently described and figured by Prillieux and Delacroix in the last fascicle of the Bulletin de la Société Mycologique de France.|| In regard to the spore formation of *Chalara Ungeri*, Sacc., found growing on pine and fir timber in the forests of Austria, Unger remarks: §

> Upon still greater magnification (Fig. 4) it is seen that the brown apices are only the sheaths of fine cylindrical cells from which terminal segments, bound together in a thread-like manner, are abjointed and pushed out. There is no doubt that these latter have the significance of brood cells, although they possess a great similarity to the spores of certain species of *Torula*.

The figure given by Unger represents quite plainly the abjunction of the conidium *within the end* of the hypha in a manner precisely similar to that shown in Plate II, Fig. 1. It differs, however, from the other

* Sitzungsberichte der K. Akademie zu München, 1879.

† Quarterly Journal Microscopical Society, XX, 1880.

‡ Reinke and Berthold, Die Zersetzung der Kartoffeln durch Pilze, 1879.

§ Botanische Zeitung, 1847, Nr. 15, T. IV.

|| Prillieux and Delacroix, *Endoconidium temulentum*, nov. gen. nov. spec. Champignon donnant au seigle des propriétés vénéneuses. Bulletin de la Société Mycologique de France, Tome VII, 2e Fasicule, p. 116.

species of *Chalara* as figured by Saccardo* and Corda,† in which the spores are represented as being abjointed, not at one but at various points within the sheath-like hyphæ‡ as in the case of *Sporoschisma mirabile*, B. & Br.;§ *Bloxamia truncata*, B. & Br.;|| *Thielavia basicola*, Zopf.;¶ *Aphanomyces stellatus*, DBy.,** and probably, although it has not been possible to examine figures, *Trullula nitidula*, Sacc.††

When the conidiophore has reached the limit of its growth the outer cell wall of the tip and the portion immediately below it ceases growing and becomes slightly tinted olive color like the mycelium. The protoplasm contained between the last septum and the apex continues to grow and ruptures or absorbs the cell wall of the tip, pushing out, seemingly as a naked protuberance of the protoplasmic contents of the cell, but probably clothing itself with an extremely thin membrane, leaving behind the sharply defined broken edge of the conidiophore. After growth has continued for a few minutes and the cylindrical protrusion has attained about the length of the diameter of the sporophore, a septum forms below the mouth of the sporophore and by the further growth of the protoplasmic contents of the mother cell the fully formed gonidium is pushed out from the sporophore only to be followed by a second spore in the same way. Fifty to sixty of these spores are frequently thus shoved out of a single vigorous sporophore, varying from one-half to one hour each in time of appearance. These hyaline conidia remained attached to each other in long chains, often doubling upon themselves in Van Tieghem cell cultures and forming several rows upon the moist underside of the cover glass (Plate II, Fig. 1).

It is surprising that in such a work as that by Dr. Alexander Zalewski, *Ueber Sporenabschnurung und Sporenabfallen bei den Pilzen*, published in 1883,‡‡ no mention should be made of such a striking modification of the author's second type of spore formation, called *Succedane reihenweise*

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* Saccardo, Fungi Italici, Figs. 29, 30, 31, 32, 35.

† Corda, Icones Fungorum, T. II, p. 9, Tab. IX, Fig. 43.

‡ Mr. J. B. Ellis and Dr. H. W. Harkness have kindly allowed the examination of *Chalara acuaria*, C. & E., and *Chalara brachyspora*, Sacc., in which the spores are borne apparently as in *Chalara Ungeri*, Sacc., by abjunction from an elongated mother cell, if the term may properly be applied to such cell with power of continuous conidia formation.

§ Berkeley, M. J. and Broome, C. E. Notices of British Fungi XL in Annals and Magazine of Natural History, June, 1850, S. 2, Vol. 5, pp. 23, 24 (same in reprint). Reference made to *Graphium penicilloides* l. c., Int. Crypt. Bot., p. 327, Fig. 74; Montaigne, Sylloge Generum Spec. Crypt., 1856, p. 306; Fresenius, Beitr. z. Mykologie, 1852. p. 17, T. VI, Fig. 26, 27, 28.

|| Ann. Nat. Hist., 1854, p. 468, T. XVI, Fig. 17. Berkeley, Int. Crypt. Bot., p. 327, Fig. 74 b.

¶ Winter, Die Pilze, Bd. I, Abth. II, p. 44; Zopf, Die Pilze, 1891, Fig. 61, p. 97; Zopf, Über die Wurzelbräune der Lupinen, eine neue Pilzkrankheit, in Zeitschrift für Pflanzenkrankheiten, Band I, Heft 2, 1891, pp. 72–76.

** Pringsheim's Jahrbücher, II, p. 170, T. XIX, Figs. 1–3; Linstedt K. Synopsis d. Saprolegniaceen, p. 63.

†† Saccardo, Michelia, II, p. 285; Sylloge Fungorum, III, p. 732.

‡‡ Flora, 1883, p. 228; Polish Inaugural Dissertation, 1883. Also in German.

Abschnurung der Sporen auf dem Scheitel der Basidie, especially after the publication in 1847 of such perspicuous figures as those of Unger's above referred to. Although not mentioned by De Bary, this method of spore abjunction is referred to by Zopf in his recent work.

The fully formed spores are thin-walled, hyaline, 16–30 by 4–9μ, bacillary, and sometimes oblong or clavate. They germinate in a few hours in water or nutrient solutions, and quite generally form a protuberance near the medial zone, exactly opposite to the germ hypha, thus giving the germinating spore the form of a cross (Pl. II, Fig. 4). The slender germ hyphæ produce sporophores, often immediately, and these push out from their apices conidia similar in all respects to the original ones (Fig. 4), and the secondary or olive conidia form on more irregular branches (Pl. II, Fig. 5).

Olive or macro-conidia.—The second mode of spore formation, which in all essentials resembles the first, takes place, in cultures, following the first, and were it not for its slower movement would be entirely simultaneous with it. Unlike the hyaline spores which are produced upon the surface of the medium, the olive conidia are formed generally deeply buried within the tissues, showing no inclination to rise into the air. The sporophores which bear them consist of simple, septate, branching hyphæ, frequently almost indistinguishable from the primary conidiophores above mentioned, and also from the sterile branches of the mycelium. The mode of spore formation differs from that just described for the hyaline conidia only in tardiness of movement and such other points as the difference in shape of the olive conidia would necessitate; in fact, the two may be said to merge into each other, the primary conidiophores producing spores resembling the olive conidia in shape and *vice versa* (Cf. Pl. II, 2 a, 5 a). Normally, the first olive conidium produced differs from those which follow in being oblong-ovate, while the succeeding ones are globose or elliptical with a small pedicel or extension at the lower extremity (Figs. 5, 6). That these conidia are produced in a manner not wholly in accordance with that described by De Bary * is demonstrated by the fact that the tip of the sporophore is ruptured, as in the formation of the hyaline conidia, upon the formation of the first spore and displays from the beginning of the spore formation (Fig. 8 *a*) until the complete abjunction of the mature spore (Fig. 8*c*) a distinct somewhat irregular edge or rim, below which is formed the true septum of the conidium (Fig. 8). In older specimens, after four or even five (the maximum number observed) conidia have been pushed out, the protoplasm below the last formed septum often becomes rounded as at Fig. 6, Plate II, clearly demonstrating that the delicate exospore of the conidium is formed within the surrounding end of the sporophore. These olive conidia are 12–19 by 6–13μ, mostly 10–11 by 12–15μ, and in the first stages of their formation are hyaline, thin-walled bodies with more or less evenly granular contents. In the

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* De Bary, Morph. and Biology of the Fungi, Eng. edition, p. 69–70.

† Zopf, Die Pilze, 1890, p. 97.

course of 24 hours they become dark colored and coarsely granular, later developing numerous oil globules which react strongly with osmic acid, giving the characteristic brown color. Occasional specimens among hundreds observed manifested a tendency to germinate either in nutrient solutions or water, and those noted sent out long hyaline branching hyphæ. These were not followed to the production of secondary sporidia. From analogy the olive conidia may be expected to serve the purpose of resting spores, possessing thick exospores and being formed largely within the soft tissues of the potato.

Pycnidia.—From a week to 9 days after sowing the hyaline conidia, a third form of fructification makes its appearance, developing with remarkable rapidity and abundance. In its initial stages the pycnidium arises as the swollen and curled or twisted tip of a vegetative hypha, or as a twist or knot in a sporophore between the conidium and its point of union with the main hypha (Plate III, Fig. 9). Although observed to be present in numerous cases, no anastomosing of different hyphæ branches seems necessary. Almost simultaneously with the first curving of the hypha tip, side branches arise which, by their growth and formation of septa, form the coarsely cellular membranaceous wall of the pycnidium. After the globose base of the pycnidium has attained its normal diameter, there arises an elongated ostiolium or beak, composed of slender septate hyphæ placed parallel, side by side, in several ranks about the orifice. By the rapid extension of these hyphæ, a long, hollow neck or beak is formed for the upward passage of the pycnospores. When the neck-forming hyphæ have reached their limit of extension, the tips become gradually tapering and form, upon maturity, long (30–60μ) slender hyaline fimbriations. Both the bulbous portions of the pycnidia and the slender necks vary greatly in size, the former being 96–224 by 96–224μ in diameter, and the latter 395–608μ long by 24–34μ at base and 14–20μ at apex.

Pycnospores.—So far as the extremely fragile nature of the interior permitted observation, the pycnospores are formed by the division of very thin-walled mother cells lining the cavity of the pycnidium. Until means can be devised for removing the difficulties lying in the way of the determination of this point, the exact mode of formation must remain in doubt. The pycnospores are hyaline, globose, or oblong, and are fastened together by a mass of refringent substance tardily soluble in water. When freshly exuded from the tip of the pycnidium, they are 5–9 by 5–9μ; but, upon immersion in water for several hours, they swell greatly, becoming 12–17 by 9–15μ. In culture media, both while remaining closely united in masses and when separated, they germinate profusely, producing upon their frequently anastomosing hyphæ, both hyaline and olive conidia, and finally pycnidia, similar to those in which they are produced. The presence of the gelatinous substance uniting the conidia, manifests itself upon the germination of the spore as a granular film, which assumes (as at Fig 4*b*, Plate III) the form of a delicate ring, often of narrow, lateral extension.

INOCULATIONS.

Healthy pôtatoes, kept in a moist atmosphere in the laboratory, upon being covered with the hyaline conidia and pycnospores of the fungus, became, in the course of a few weeks, badly diseased with the typical black rot. The fungus is capable of entering the eyes of the potato and is nourished by the small, dead fibrils often connected with the eyes. In inoculations, the diseased portions began in or near the eye. To convince the most skeptical, initials were scratched upon the surface of one potato with a sterile needle, and the surface coated with hyaline conidia in water. In three weeks the initials appeared in typical black-rot lines against the brown back ground.

PROBABLE LIFE HISTORY.

The life cycle of the parasite, although not certainly completed by these different forms, may cover a period of several weeks and perhaps months. The abundant mycelium present in the diseased roots planted in the hotbed for the purpose of obtaining sprouts infects the young shoots as described. This infection may take place either through the medium of spores or by the growth of mycelium from the diseased areas themselves. Diseased sprouts planted in the field produce diseased roots which may spread the disease to other hills either through the soil directly or by means of the numerous fibrils from other plants. These infected areas, although perhaps inconspicuous at first, grow steadily in diameter not being checked by digging, and when the potatoes are stored for keeping continue to grow in the root and at the same time to produce the various forms of spores. These reproductive bodies when supplied with sufficient moisture are capable of infecting, unaided, sound potatoes through their eyes. Thus one diseased potato when stored in a bin of healthy ones is capable of infecting all those in the bin and causing them to rot in a short time.

To what extent the fungus is able to live upon the dead vegetable matter of the soil has not been determined, but from its omnivorous habits numerous substances might be expected to nourish it in an active state. The fact that the parasite grows luxuriantly upon strong *nahrlosung* agar would perhaps indicate its ability to inhabit different stable manures applied to the potato fields, and although no experiments were attempted to show whether a passage through the digestive canal would kill the spores, circumstantial evidence points strongly to the belief that such passage does not destroy all forms.

Ceratocystis fimbriata probably winters not only in the roots used for seed the following spring, but in the soil itself, upon decaying portions of sweet potato roots and other vegetable substances. The sclerotial stage mentioned may be found to compose the principal resting stage of the parasite.

PREVENTIVE MEASURES.

I. The first and most important precaution to be taken in combating the disease is to plant only perfectly healthy seed in the hotbed, even

if it is necessary to import such. This preventive measure is most essential, as diseased seed will give diseased sprouts, which in turn will grow a crop of worthless potatoes.

II. The selection of healthy sprouts is plainly necessary in case the fungus gets into the hotbeds, and under no circumstances should diseased plants be put into the field. The test of using copper fungicides in the hotbed has not been made, but from analogy seems to promise assistance. If the fungicide is used the shoots should be kept green with it until pulled.

III. Fields which have become so impregnated by the disease that they refuse to grow profitable crops had best be added to the regular farm rotation. This method will, if continued for several years, allow the accumulated infective material to burn itself out by consuming all available food material in the soil.

IV. Decaying roots and the refuse after digging should be carefully removed from the field and burned, as such débris adds to the food of the parasite.

V. The use of large quantities of barnyard manure probably favors the development of the trouble, since it adds greatly to the decaying vegetable matter of the soil. Where the use of commercial fertilizers can be made to take the place of manure it will certainly be desirable to make the change.

VI. Although no experiments have yet been completed upon the matter, it is probable the spread of the disease in the bin may be checked by dipping the roots in one of the copper mixtures, preferably the ammoniacal solution, before storing for the winter. What effect tobacco smoke or the fumes of sulphur would have in checking the disease in the bins remains to be ascertained.

Experiments are now under way to ascertain, if possible, the effect of the use of the ammoniacal solution of copper carbonate in preventing the disease. Hotbed, field, and bin experiments are in progress, and it is hoped definite results will be obtained.

SUMMARY.

I. The black rot of the sweet potato, both upon young shoots, causing "black shank," and upon mature roots, is caused by the parasitic action of the fungus *Ceratocystis fimbriata*, Ellis and Halsted.

II. Portions of diseased tissue develop, when placed upon various media, abundant growths of the parasitic fungus.

III. Three modes of spore formation are present, two endogenous from the tips of specialized hyphæ, the third from cyst-like bodies. The connection of a sclerotial form, although not demonstrated by culture, is strongly suspected.

IV. Spores grown in cultures are capable of inoculating healthy roots through the broken cuticle or through the eyes.

DESCRIPTION OF PLATES.

Plate I, *Ceratocystis fimbriata*, Ell. & Hals.

Fig. 1. Sweet Potato showing blackened area, inhabited by the parasite.
2. Cross section of the same.

Plate II, *Ceratocystis fimbriata*, Ell. & Hals.

Fig. 1. Sporophore of hyaline conidia figured 1 p. m. 1*a*, the same figured 1:50 p. m. 1*b*, the same at 2:15 p. m. × 550. From test-tube cultures of sweet potato agar-agar.
2. Group of hyaline conidia, showing variations in form from test-tube culture. 2*a*, the same from plate culture × 400.
3. Group of hyaline conidia sporophores, showing spore formation × 300. From test-tube cultures.
4. Germinating hyaline conidia from cultures 24–48 hours old in sweet potato agar. 4*a*, young germ hypha with hyaline conidium forming. 4*b*, hyaline conidium lately expelled from sporophore. 4*c*, commencement of sporophore or branch of hypha of germination × 550.
5. Sporophores with olive conidia issuing from tips. 5*a*, characteristic primary spore first formed × 550.
6. Sporophore of olive conidium greatly enlarged × 1,500. *a*, ruptured outer wall of sporophore. *b*, protoplasmic contents of mother cell.
7. Olive conidia germinating × 550.
8. Successive stages in formation of olive conidia. 8*a*, sporophore and spore figured 12:15 p. m. 8*b*, same 2 p. m. 8*c*, same 4:35 p. m. 8*d*, same 6:25 p. m. 8*e*, 9 a. m.
9. Primary growth of mycelial hyphæ from hyaline conidium.

Plate III, *Ceratocystis fimbriata*, Ell. & Hals.

Fig. 1. Mature pycnidium × 200. 1*a*, gelatinous mass of exuded spores.
2. Fimbriate tip of beak or ostiolium × 500.
3. Cross section of pycnidium showing large thin walled cells, previous to spore formation × 300.
4. Gelatinous mass of pycnospores × 550. 4*a* isolated spores shortly after immersion in iodine. 4*b* pycnospore after 48 hours in sweet potato agar culture. *N*, nucleus; *G*, ring of gelatinous granules.
5. Cross section of pycnidium beak near base × 550.
6. Primary growth of mycelial hyphæ from pycnospore × 200.
7. Anastomosing hyphæ abundant on mycelium from pycnospores and hyaline conidia × 440.
8. Germinating pycnospores. 8*a* ring of gelatinous uniting substance. 8*b* promycelium in form of a sporophore with hyaline conidium issuing × 550.
9. Primary stage in development of pycnidium × 550.
10. Early stage in development of pycnidium × 550.
11. Immature pycnidium × 400.

EXPERIMENTS IN THE TREATMENT OF PLANT DISEASES.

By B. T. Galloway.

(Plate IV.)

Part III.

In addition to the field work conducted in 1890 by the Division of Vegetable Pathology and set forth in Parts I and II of this article, a series of experiments were made under our direction by field agents located in various parts of the Union. The reports of these agents have all been received, and while it is our usual custom to publish them in the form of a special bulletin several reasons make it more desirable to give them in a condensed form here.

TREATMENT OF GRAPE DISEASES.

These experiments were carried on at Greenville, South Carolina; Vineland, New Jersey; and Neosho, Missouri. The work in the main was planned to throw additional light on the treatment of black rot, which is everywhere recognized as being the most destructive of all grape maladies. The questions we were desirous of obtaining more information upon may be briefly summarized as follows:

I. A comparison of the fungicides given below as regards cost, efficiency, and effects on the healthy foliage and fruit.

(*a*) Bordeaux mixture prepared in accordance with the usual formula, *i. e.*, copper sulphate 6 pounds, lime 4 pounds, and water 22 gallons.

(*b*) Bordeaux mixture prepared the same as *a*, then allowed to settle. After this has taken place drawing off the clear liquid and drying the sediment the latter being simply mixed with water when used. The object in using this preparation was to determine if possible whether the Bordeaux mixture prepared in advance was as effective as that made in the usual way. The question has considerable practical importance as there is an increasing demand for a mixture ready for use. This demand is mostly from small growers who do not care to go to the trouble of buying the copper and lime and making their own mixture.

(*c*) Modified eau celeste containing copper sulphate 4 pounds, aqua ammonia 3 pints, carbonate of soda 5 pounds.

(*d*) Copper carbonate in suspension, 3 ounces to 22 gallons. This being a much cheaper preparation than the ammoniacal copper carbonate solution, it was thought best to give it a thorough trial.

(*e*) Simple milk of lime made by dissolving 3 pounds of lime in 25 gallons of water.

(*f*) Solution of copper acetate, 2 pounds to 22 gallons.

(*g*) Mixture No. 5 consisting of equal parts of ammoniated copper sulphate and ammonia carbonate. Used at the rate of 1 pound to

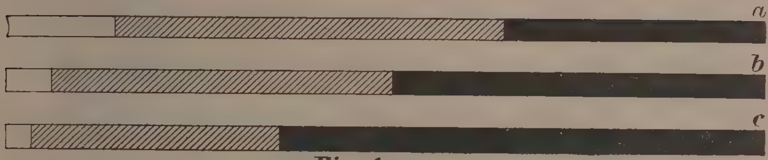

Fig. 4.

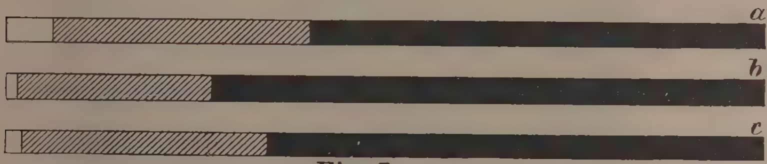

Fig. 5.

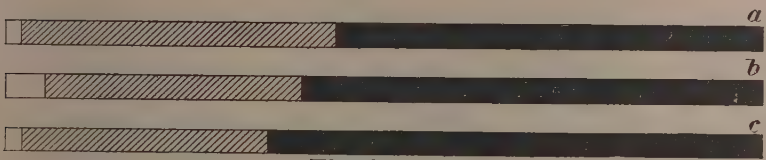

Fig. 6.

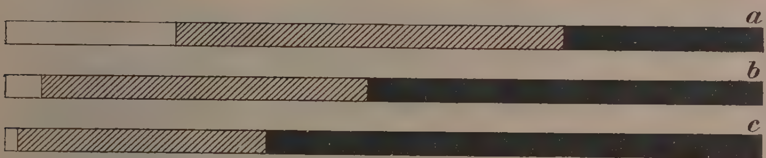

Fig. 7.

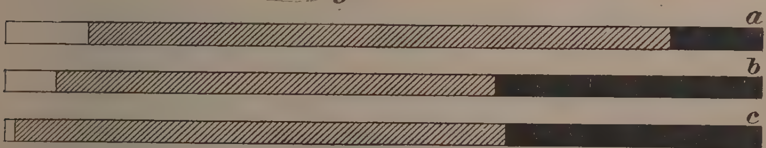

Fig. 8.

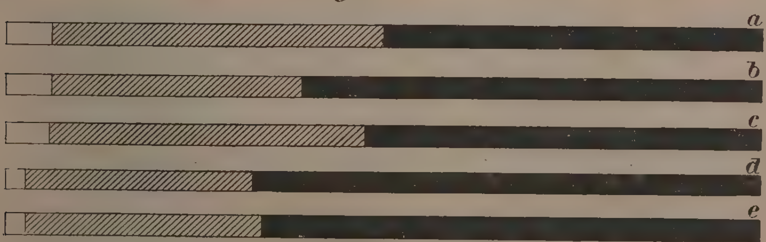

Fig. 9.

GALLOWAY, ON EXPERIMENTS IN TREATMENT OF PLANT DISEASES.

25 gallons of water. Mixture No. 5 is practically eau celeste in dry concentrated form.

(*h*) Ammoniacal copper carbonate solution, 3 ounces copper carbonate dissolved in 1 quart of ammonia, and diluted with 22 gallons of water.

II. The value of a mixed treatment, consisting of three early treatments of the Bordeaux mixture and three late sprayings of the ammoniacal solution.

III. The value of early against late sprayings. By early is meant the first treatment when the buds begin to swell, and by late the first treatment when the grapes are the size of bird shot.

EXPERIMENTS AT GREENVILLE, SOUTH CAROLINA.

The work at this place was conducted A. M. Howell, who is to be commended for the care devoted to it. The vineyard chosen by Mr. Howell for the experiment was one which had been well cultivated and cleared, but had never before received any treatment for vine diseases and for 3 years had regularly lost from 50 to 75 per cent of its crop by black rot. Besides this it had been invaded by downy mildew and anthracnose.

The variety selected for experimental treatment was the Concord, because of its regular habits of growth and fruitage, and its unvarying susceptibility to rot. In accordance with instructions the vineyard was divided into 14 contiguous plats, 11 consisting of 58 and 3 of 50 vines each. In the 11 plats, containing 58 vines each, a sub-plat of 8 vines was marked off in the center of each. These sub-plats were left without treatment. The vineyard was then divided as follows: Three plats of 50 vines each, containing no sub-plats; eleven main plats containing 50 vines each having in the center a sub-plat of 8 vines each. The different plats were designated by the letters of the alphabet from A to W, inclusive, as shown in the following diagram:

A	B	A
C	D	C
E	F	E
G	H	G
I	J	I
K	L	K
M	N	M
O	P	O
Q	R	Q
S	T	S
S	T	S
U		U
V		V
W		W

FIG. 1.

The variation in regard to these was for the purpose of bringing out the value of early spraying, as will be shown later.

The first spraying was made 10 days before blooming, and would have been applied earlier but for a delay in the arrival of some of the chemicals. The weather had been dry for 2 weeks and no disease was showing on the leaves. The next day, however, a rainy spell set in, lasting 5 days. The second treatment was also given on a clear day and the first traces of black rot had been discovered the day before. There were rains on May 18, 19, 20, and then none until June 1. The day after the fourth treatment there was a light rain (June 15) and this was followed by a drought which put an end to any infection of black rot for the season.

In order to get a fair estimate as to the value of the various treatments the diseased and healthy berries on both the treated and untreated plats were carefully counted and weighed. The weight of diseased fruit was estimated by counting, in several cases, the number of berries in a pound of sound fruit, obtaining an average number, and dividing the number of diseased berries by it. The results of this work is shown in tabular form below.

Plat.	Number of vines, date, and manner of treatment.	Yield of sound fruit per plat.	Average yield per vine.	Number of rotten berries per plat.	Number of rotten berries per vine.	Total rot per plat in pounds of sound fruit.	Percentage of loss.	Total cost of treatment
		Pounds.	*Pounds.*					*Cents.*
A	50 vines treated April 30, May 15 and 30, and June 14, with Bordeaux mixture	260	5.20	275	5.50	1.56	.6	.54
B	8 untreated vines	23	2.87	2,464	308	14	38	.00
C	50 vines treated April 30, May 15 and 30, and June 14, with ammoniacal copper carbonate solution	255	5.10	236	4.72	1.34	.6	.22
D	8 untreated vines	20	2.50	2,816	352	16	45	.00
E	50 vines treated April 30, May 15 and 30, and June 14, with Bordeaux mixture and ammoniacal solution	255	5.10	188	3.76	1.06	.4	.40
F	8 untreated vines	20	2.50	2,827	353	16	45	.00
G	50 vines treated April 30, May 15 and 30, and June 14, with modified eau celeste	260	5.20	68	1.36	.33	.1	Not given.
H	8 untreated vines	24	3	2,466	308	14	37	.00
I	50 vines treated April 30, May 15 and 30, and June 14, with copper carbonate in suspension	246	4.92	268	5.36	1.52	.6	.11
J	8 untreated vines	18	2.25	2,998	375	17	48	.00
K	50 vines treated April 30, May 15 and 30, and June 14, with milk of lime	190	3.80	8,599	172	48.86	20	.03
L	8 untreated vines	20	2.50	2,819	352	16	45	.00
M	50 vines treated April 30, May 15 and 30, and June 14, with Bordeaux mixture prepared in advance	230	4.60	367	7.34	2.08	.9	.54
N	8 untreated vines	22	2.75	2,126	266	12	35	.00
O	50 vines treated April 30, May 15 and 30, and June 14, with Bordeaux mixture, one-half strength prepared in advance	180	3.60	8,730	174.60	49.60	21.50	.27
P	8 untreated vines	17	2.12	2,372	284	13	43	.00

Plat.	Number of vines, date, and manner of treatment.	Yield of sound fruit per plat.	Average yield per vine.	Number of rotten berries per plat.	Number of rotten berries per vine.	Total rot per plat in pounds of sound fruit.	Percentage of loss.	Total cost of treatments.
		Pounds.	*Pounds.*					*Cents.*
Q	50 vines treated April 30, May 15 and 30, and June 14, with acetate of copper solution	260	5.20	277	5.54	1.57	.6	Not given.
R	8 untreated vines	20	2.50	2,176	272	12	37.50	.00
S	50 vines treated April 30, May 15 and 30, and June 14 with mixture No. 5	255	5.10	113	2.23	.63	.25	Not given.
T	8 untreated vines	25	3.12	2,472	309	14	36	.00
S′	50 vines treated April 30, May 15 and 30, and June 14 with mixture No. 5	216	4.32	312	6.24	1.77	.8	Not given.
T′	8 untreated vines	22	2.75	2,287	286	13	37	.00
U	50 vines treated May 17 and June 2 with Bordeaux mixture; late treatment	210	4.20	2,112	42.24	12	5	.22
V	50 vines treated May 25, June 9, with Bordeaux mixture, 8 days later than U	200	4	2,040	40.80	11.59	5.50	.27
W	50 vines treated May 17 and June 2 same as U, excepting ammoniacal solution was used	220	4.40	2,618	52.36	15	6	.11

Very little comment upon the foregoing table is necessary, as we believe it fully explains itself and in a measure answers the questions summarized in the first part of this article. It will be seen that seven of the fungicides used reduced the amount of rot to less than 1 per cent, while on the untreated vines the loss averaged 40 per cent. This was much less than in an ordinary season, on account of the dry weather. In such cases about 75 per cent would have probably been lost. The present season was not one either that furnished a good test of fungicides. If more rain had fallen there is little doubt that there would have been more rot on the treated plats, more striking differences in the degrees of efficacy of the different fungicides, and more grapes actually saved. That is, the difference between the amount lost on the treated and untreated plats would have been much greater.

As to the comparative value of the fungicides, the ratios found in the figures as given can scarcely be considered such as will hold for other seasons and in different climates. This season's work has shown that a difference in locality affects the action of fungicides on foliage; for example, the copper acetate, which proved very efficacious with Mr. Howell, of South Carolina, burned the foliage so badly in Missouri as to ruin the crop for the year.

Milk of lime and precipitated Bordeaux mixture, one-half strength, both proved ineffectual. As regards efficiency the other fungicides stood in the following order:

Modified eau celeste.
Mixture No. 5.
Bordeaux mixture and ammoniacal solution.
Bordeaux mixture.
Copper acetate.
Ammoniacal solution.
Copper carbonate in suspension.
Precipitated Bordeaux.

The loss from not beginning the treatments early was not as striking as was anticipated, but there is no doubt that a wet spring would have shown a more decided contrast between the effects of late and early treatments. As it was, a difference of 8 days in the date of the first application made a difference of 5 per cent in the amount of rot, showing that it is not safe to begin treatments later than the last of April in the Southern grape-growing districts, or, in general, about 10 days before the blooming.

EXPERIMENTS AT CHARLOTTESVILLE, VIRGINIA; VINELAND, NEW JERSEY; AND NEOSHO, MISSOURI.

The experiments at the foregoing places cover practically the same ground as those given in detail in the preceding notes; in fact, the same plan was followed at each place. Without going into further details, for which we have not space here, the entire work may be summarized as follows:

I. All things considered, the Bordeaux mixture still heads the list as a preventive of black rot.

II. The Bordeaux mixture prepared in advance according to the directions already given is not satisfactory, and is therefore not worthy of further use.

III. Copper carbonate in suspension and milk of lime are comparatively useless as preventives of black rot and other grape diseases.

IV. Copper acetate has fungicidal value, but in most sections it is likely to injure the foliage.

V. The cheapest and most effectual remedy for black rot and downy mildew, taking everything into consideration, is the ammoniacal solution of copper carbonate. Next to this is a mixed treatment consisting of two or three early sprayings of Bordeaux mixture and the same number of late treatments with ammoniacal solution.

VI. Mixture No. 5, while possessing value as a fungicide, is likely to injure the foliage. Until this difficulty is overcome its use on a large scale can not be recommended.

VII. Early sprayings are absolutely necessary to insure the best results in the treatment of black rot.

As heretofore, experiments in the treatment of a number of plant diseases were carried on under our direction in Wisconsin by Prof. E. S. Goff, of the State Experiment Station. Following is Professor Goff's report in full.

TREATMENT OF FUNGOUS DISEASES.

Report of E. S. Goff, Madison, Wisconsin.

Sir: I have the honor to report the results of experimental work in the treatment of certain fungous diseases of plants as per plan approved by you in May last.

E. S. Goff,
Special Agent, Madison, Wisconsin.

Mr. B. T. Galloway,
Chief of the Division of Vegetable Pathology,
U. S. Department of Agriculture.

The fruit farm of Mr. A. L. Hatch, on which the experiments here reported were conducted, lies 3¼ miles southeast of the village of Ithaca, Richland County, Wisconsin. It crowns the summit of a hillock, and is not far from 1,000 feet above sea level. The soil is a light clay loam, underlaid by Potsdam Sandstone, and is in a good state of cultivation.

The plan of work arranged included treatment for the apple scab, *Fusicladium dendriticum*, Fckl., the Septoria of the raspberry and blackberry, *Septoria rubi*, West, and the potato rot. The weather during the early summer, however, proved excessively rainy,* and the effects of some of the applications were undoubtedly destroyed by copious showers soon after the treatments. It was sometimes necessary to postpone applications from day to day owing to the very frequent rains. The somewhat meager results secured in the treatment of apple scab, as compared with the season of 1889, are probably attributable to the excessive rainfall of the early part of the summer.

In all of the experiments the spraying was performed with the so-called "Little Climax" force pump, fitted with the Nixon nozzle. The Vermorel nozzle was tested for applying the Bordeaux mixture, but was little used, as the Nixon nozzle was satisfactory. The liquids were always applied in sufficient quantity to pretty thoroughly wet the foliage.

EXPERIMENT IN THE TREATMENT OF APPLE SCAB.

The fungicides tested the past season for preventing apple scab were:

I. Copper carbonate dissolved in ammonia, as used in 1889, and also suspended in water.

II. The sulphur powder, so called, tested in 1889, and introduced by Mr. E. Bean, of Jacksonville, Florida.

III. The compound of ammoniated copper sulphate and ammonium carbonate furnished by your department as Mixture No. 5.

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* No systematic meteorological records were kept at Ithaca during the early part of the season, but the following notes were made by Mr. Hatch: "Heavy rain May 9, 10, and 12; May 31, rains since the 13th, severe and frequent; rain June 3, 4, and 5; June 15, rained heavily almost every day or night since the 7th; June 18, hard rain; June 29, heavy rain June 20, 21, 22, 23, and 24, thunder on the 24th, very hot since the 23rd, 90° to 95° several days, with very humid atmosphere, more rain on the 29th; July 11, very heavy rain; July 13, rain with wind and thunder; August 19, weather very dry since middle of July." After August 1, a careful meteorological record was kept by a daughter of Mr. Hatch, in accordance with the rules of the Signal Service, from which it appears that 3.46 inches of rain fell on 12 days during August and 2.5 inches on 6 days during September.

At Madison 7.02 inches of rain fell on 13 days in June and 1.81 inches in 7 days in July.

Plan of the work.—The questions to which answer was sought in the use of these materials, and the methods employed to answer them were:

I. The comparative efficacy of the three compounds named in preventing apple scab.

Two trees of the Fameuse variety were sprayed with each of the three compounds, and their crops compared with those of check trees not sprayed at all.

II. The efficacy of copper carbonate applied suspended in water, as compared with that dissolved in ammonia.

It was found in 1889 that the ammonia, unless very largely diluted, endangers the foliage, and gives the fruit a russety appearance. It also dissolves the arsenic of Paris green or London purple when used for the codling moth at the same spraying, and this indirectly causes injury to the foliage. To answer the second question, two Fameuse trees were sprayed with copper carbonate dissolved in ammonia and two others with the same material simply stirred in water, as we apply Paris green. The crops of these two pairs of trees were compared with each other, and also with those of the check trees.

III. The value of treatment previous to the opening of the flowers.

Two Fameuse trees were sprayed once with ammoniacal copper carbonate before bloom and three times after, and their crops compared with those of two other trees sprayed four times after bloom. The crops of the four trees were compared with those of check trees not sprayed. Also, two trees of the Canada peach variety were sprayed with suspended copper carbonate twice before bloom and twice after, and their crops compared with those of two others sprayed with the same four times after bloom, and also with those of check trees.

IV. The number of treatments necessary to secure the most beneficial results.

Two Fameuse trees were sprayed with ammoniacal copper carbonate 2, 4, 6, and 8 times respectively, and the crops of the different pairs compared with each other and with check trees not sprayed at all.

The strength at which the fungicides were used.—The copper carbonate was in every case of the precipitated form and when applied in the diluted ammoniacal solution was used at the rate of an ounce of the salt to 25 gallons of water. One ounce was dissolved in a quart of ammonia (strength 22° Baumé) and the solution added to the water just before the treatment at the rate named.

When the copper carbonate was applied in suspension an ounce was first well stirred in a small quantity of water and the mixture thus formed was added to 12½ gallons of water.

The sulphur powder was used according to the directions on the package, *i. e.*, 10 pounds were added to a barrel of water and allowed to stand a few hours before use. The yellow colored liquid resulting was employed without dilution. As the barrel became nearly empty it was again filled with water and the solution used as before.

The mixture No. 5 was used as suggested by you, viz, 12 ounces to 22 gallons of water in the first two treatments, but owing to injury to the foliage it was diluted one-third in the later sprayings.

The trees selected for the experiment were of medium size, and all promised a full crop of fruit, though as appears from the table on a succeeding page, all did not mature a full crop. None of the trees used in the experiment of 1889 were employed in the experiment here reported. The first treatment was given on May 5, and others were made May 13, 31, June 5, 16, 28, July 14, 25, August 6, 19, and September 2. Of course all the trees were not treated at all the sprayings. The treatment of June 5 was intended to supplement that of May 31, much rain having fallen between these dates. As the apples showed indications of maturity the entire crop on each of the trees selected for the experiment was gathered and assorted into three qualities as follows:

(1) Fruits quite free from scab.

(2) Fruits showing scab spots but not of sufficient size or number to distort the apples.

(3) Fruits more affected.

In assorting the crops only the scab was considered; size and insect injury being ignored. Some of the fruits placed in the first quality were badly distorted by insect injuries, and were very small in size. In like manner some fruits of comparatively large size were of necessity placed in the third quality.

The numerical data relating to the experiment are chiefly grouped together in the accompanying table but as this table is necessarily somewhat complicated the more important points brought out are graphically illustrated on succeeding pages.

Tree No.	Variety.	Sprayed with—	Number of times sprayed.*	Dates when sprayed.
1	Canada peach	Suspended copper carbonate.	2 before bloom; 2 after bloom.	May 5, 13, and 31, June 5.
2	....do	....do	....do	Do.
3	....do	....do	4	May 31, June 5,† 16, and 28, July 14.
4	....do	....do	4	Do.
5	....do	Check—not sprayed		
6	....do	....do		
7	Fameuse	Suspended copper carbonate.	6	May 31, June 5,† 16, and 28, July 14 and 25, Aug. 16.
8	....do	....do	6	Do.
9	....do	Ammoniacal copper carbonate.	6	Do.
10	....do	....do	6	Do.
11	....do	....do	2	May 31, June 5† and 28.
12	....do	....do	2	Do.
13	....do	....do	4	May 31, June 5,† 16, and 28, July 14
14	....do	....do	4	Do.
15	....do	....do	8	May 31, June 5,† 16, and 28, July 14 and 25, Aug. 6 and 19, Sept. 2.
16	....do	....do	8	Do.
17	....do	....do	1 before bloom; 3 after bloom.	May 7 and 31, June 5,† 16, and 28.
18	....do	....do	....do	Do.
19	....do	Bean's Sulphur Powder.	6	May 31, June 5,† 16, and 28, July 14 and 25, Aug. 6.
20	....do	....do	6	Do.
21	....do	Mixture No. 5	8	May 31, June 5,† 16, and 28, July 14 and 25, Aug. 6 and 19, Sept. 2.
22	....do	....do	8	Do.
23	....do	Check—not sprayed		
24	....do			

* Always sprayed *after the petals had fallen* unless otherwise stated.
† The spraying of June 5 was intended to supplement that of May 31.

Tree No.	Variety.	Number of fruits.	Per cent of fruits in—			Average for the two trees; per cent of fruits in—			Weights of 100 fruits.		
			First quality.	Second quality.	Third quality.	First quality.	Second quality.	Third quality.	First quality.	Second quality.	Third quality.
									Ozs.	*Ozs.*	*Ozs.*
1	Canada peach	257	16.34	77.43	6.23						
2	....do	211	6.64	76.30	17.06	11.49	76.86	11.14			
3	....do	175	5.71	72.57	21.72						
4	....do	138	7.25	45.65	47.10	6.48	59.11	34.41			
5	....do	238	2.94	61.35	35.71						
6	....do	865	0.36	68.98	30.66	1.65	65.16	33.18			
7	Fameuse	633	3.79	41.71	54.38				313	275	259
8	....do	632	1.58	40.98	57.44	2.68	41.34	55.91	300	286	199
9	....do	1,027	2.82	32.91	64.27				300	281	202
10	....do	850	8.82	35.30	55.88	5.82	34.10	60.07	262	242	181
11	....do	906	1.55	25.94	72.51				279	259	186
12	....do	1,161	3.16	37.15	59.69	2.35	31.54	66.10	154	243	172
13	....do	1,042	5.57	42.23	52.20				288	257	178
14	....do	968	5.58	43.80	50.62	5.57	43.01	51.41	280	254	182
15	....do	1,746	4.07	44.67	51.26				280	258	176
16	....do	581	7.84	45.32	46.84	5.95	44.99	49.05	288	267	198
17	....do	912	20.61	56.47	22.92				241	272	217
18	....do	1,332	25.60	47.22	27.18	23.10	51.84	25.05	283	255	198
19	....do	13,59	1.18	23.18	75.64				256	254	182
20	....do	707	1.82	29.00	69.18	1.50	26.09	72.41	300	290	203
21	....do	1,096	18.70	52.56	28.74				221	217	166
22	....do	719	9.04	50.77	40.19	13.87	51.66	34.46	245	231	186
23	....do	258	1.16	22.87	75.97				300	265	182
24	....do	762	3.59	42.82	53.59	2.37	32.84	64.78	307	259	189

The comparative efficacy of copper carbonate, sulphur powder, and Mixture No. 5 in preventing Apple Scab.—This will appear by consulting Fig. 1 and Pl. IV, Fig. 5. In the experiment the trees were sprayed six times with the sulphur powder and eight times with the Mixture No. 5. We therefore compare those treated with the former with the trees sprayed six times with the ammoniacal copper carbonate, and those treated with the latter with those sprayed eight times with the ammoniacal copper carbonate. In Fig. 4, Pl. IV, is shown the proportion of fruits in each of the three qualities from the trees sprayed eight times with the Mixture No. 5, and the copper carbonate as compared with those from the untreated trees.

The white portion represents the first quality, the diagonal lines the second, and the black portion the third quality.

From this it appears that the Mixture No. 5 was considerably the more efficacious. In Fig. 5 we compare the effect of six treatments with the sulphur powder and ammoniacal copper carbonate with that of the check trees, from which it would seem that the sulphur powder actually appeared to increase the amount of scab. It is more probable, however, that the trees treated with this material were from some cause more than usually affected with the disease which the sulphur compound, possibly owing to its ready solubility which caused it to be easily washed off by the rains, entirely failed to prevent.

The efficacy of copper carbonate suspended in water as compared with that dissolved in ammonia.—From Fig. 6 it is evident that the results from six sprayings of copper carbonate applied in suspension and in ammoniacal solution were very meager in both cases. The first and third qualities were larger in the case of the solution, while the second was larger in that of the suspended copper carbonate. If the results may be assumed to teach anything it would seem that there was little difference in the efficacy of the two methods of application.

From Fig. 8, in which the data represent the results of spraying the Canada peach apple with suspended copper carbonate before and after bloom, the benefit from the treatment before bloom is very perceptible, which indicates that this method of using copper carbonate is capable of giving good results.

The value of treatment previous to the opening of the flowers.—From Fig. 7 it is evident that one treatment of the Fameuse apple before the flower had opened with three treatments after the petals had fallen was much more efficacious in preventing the scab than four treatments made after the falling of the petals, a result which is corroborated in Fig. 8, which represents the results secured in treating two trees of the Canada Peach twice before bloom and twice after, as compared with four treatments after bloom.

The number of treatments necessary to secure the most beneficial results.—From Fig. 9 it appears that eight treatments gave only slightly better results than four, but that four gave considerably better than two. The first two treatments succeeding the falling of the petals (made May 31 and June 16), it would appear, gave absolutely no results, while the two made June 28 and July 14 seem to have proved beneficial. The excessive rains during the early part of June doubtless washed off the fungicides from the foliage before they had time to act, and at the same time promoted the growth of the fungus. The lesson suggested is that treatments made after midsummer are of doubtful value.

To what extent does the scab reduce the size of the fruit?—As will appear from the table on a preceding page all of the fruits of the Fameuse apple in the different qualities were weighed. These weights furnish data from which we may compute with a fair degree of accuracy the influence of the scab in reducing the size of the apples. As only the scab was considered in assorting, we are perhaps justified in assuming that the reduced size of the scabby fruits was due to the exhaustive action of the fungus, and that had all the apples been free from the disease all would have been as large as those of the first quality. From the data it appears that, averaging the crop from all of the Fameuse trees, the fruits of the first quality weighed 262 ounces per hun-

dred, those of the second 258, and those of the third 189. The average weight of the fruits in the different qualities appears below in Fig. 2.

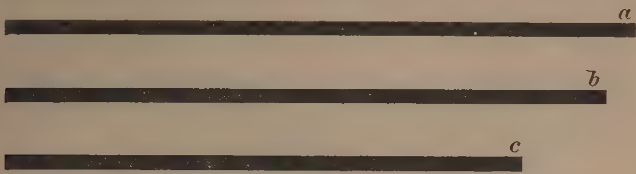

FIG. 2.—*a*, first quality; *b*, second quality; *c*, third quality.

Had all the fruits from the eighteen Fameuse trees been equal in size to those of the first quality the actual increase of the crop would have been a trifle over 413 pounds, or more than 17.8 per cent of the entire yield of apples. This, it should be remembered, only represents the effect of the scab in reducing the size of the fruits actually developed. It does not take into account the injury to the appearance of these fruits, the fruits that were prevented from developing, nor the injury wrought by the fungus to the vigor of the tree.

Cost of the treatments.—From the materials and the time consumed in the treatments, counting copper carbonate at 50 cents per pound, ammonia $1.50 per gallon, and labor 15 cents per hour, I have computed the cost of the treatments with these materials approximately as follows:

Cost for spraying one tree once with ammoniacal copper carbonate:

For materials	$.022
For labor	.0375
Total	.0595

Or, including labor of preparing, about 6 cents.

Suspended copper carbonate, using double the amount as in the above:

For materials	$.0039
For labor	.0375
Total	.0414

Or, including labor of preparing, about 4.2 cents.

These prices could be considerably reduced by purchasing the materials in quantity and making the applications with a larger force pump.

I have not been informed as to the cost of the sulphur powder or Mixture No. 5.*

Recapitulation.—The results of the experiment in the treatment of apple scab, described in the foregoing pages, suggest the following conclusions:

I. That in seasons of excessive rains in early summer the scab on badly infested trees can not be wholly prevented by the treatments given in this experiment.

II. That of the substances tested the mixture of ammonium carbonate and ammoniated copper sulphate (designated as Mixture No. 5)† was most efficient.

III. That the precipitated copper carbonate applied stirred in water, as we use Paris green, is nearly or quite as efficient as when one-half the amount was applied dissolved in ammonia, a point which, if confirmed by further trials, is important, as it will render possible the use of Paris green for the codling moth at the same spraying with the fungicide.

IV. That early treatments, and especially at least one treatment previous to the opening of the flowers, is extremely important.

* I mention, on the authority of Dr. S. M. Babcock, that this material is, when dissolved in water, very similar in chemical composition to the ammoniacal copper carbonate. On adding water to the mixture a chemical change takes place, the result of which is the formation of copper carbonate dissolved in ammonia and ammonium sulphate.

† Mixture No. 5 costs practically the same as the ammoniacal solution.

V. That sprayings after midsummer are at best of doubtful value.

VI. That on trees badly infested with scab the fruits that develop may be so far reduced in size by the fungus as to diminish the crop nearly 20 per cent; but this is doubtless but a small part of the injury actually produced.

In conclusion, I would recommend that in future experiments a larger number of trees be employed as duplicates. A study of the results secured in this experiment, as well as those gained in the trial of 1889, makes it clear that two trees are not always sufficient to furnish data for drawing definite conclusions.

EXPERIMENTS IN THE TREATMENT OF THE SEPTORIA OF THE RASPBERRY AND BLACKBERRY.

The fungicides tested for the Septoria of the raspberry and blackberry were:

I. Bordeaux mixture.

II. Ammoniacal copper carbonate.

III. The mixture of ammoniated copper sulphate and ammonium carbonate, used for the apple scab as Mixture No. 5.

The Bordeaux mixture was made by slacking 6 pounds of lime in one vessel, and dissolving 4 pounds of copper sulphate in another, uniting the contents of the two vessels on the cooling of the lime and diluting the whole with water to 22 gallons.

After the first two treatments, the Bordeaux mixture was diluted one-third, as the foliage showed indications of injury.

The other two fungicides were used in the first two treatments of the strength noted in the experiment for apple scab, viz, an ounce of copper carbonate dissolved in a quart of ammonia, and the solution diluted with 25 gallons of water; 12 ounces of the mixture No. 5 dissolved in 22 gallons of water. After the second spraying, the solution of mixture No. 5 was diluted one-third for the reason named above.

The varieties of raspberry selected for the experiment were Cuthbert for red, and Tyler and Gregg for black; those of the blackberry were Stone's hardy and Ancient Briton. All were growing in somewhat dense rows, and at the time of the first spraying, May 31, presented a thrifty appearance, and gave promise of a good crop of berries. At this time the leaves were nearly full grown and the flower buds though visible had not yet opened. Forty feet of row of each variety selected for the experiment was treated at the different sprayings with each of the fungicides named. Treatments were given on May 31, June 5, 18, 28, July 7 and 14. In the treatment of July 28, the Tyler and Cuthbert raspberries were omitted, as there were unmistakable indications of injury to the foliage. In the treatment of July 7 and 14 all of the raspberries were omitted, as the fruit was beginning to ripen.

During my visit to Mr. Hatch's place, on July 24, it was evident that all of the fungicides used had injured the foliage to some extent on both the raspberry and blackberry. The injury seemed most pronounced in the case of Mixture No. 5, and least in that of ammoniacal copper carbonate. The foliage of the black cap raspberries showed more injury than that of the red, and there were indications that the crop would be injured or at least retarded. It was also evident that the Bordeaux mixture, on account of its adherence to the fruit, is very poorly adapted for use upon these crops. The Septoria was visible at this time on untreated rows of both the raspberry and blackberry. Where the treatments had been given, the blackness of the foliage rendered it difficult to decide to what extent the Septoria was active.

The crop on all of the treated plants, except those of the Tyler raspberry,* and of the plants set off as checks was measured by Mr. Hatch at each picking.

As the best means of determining the results of the treatments upon the yield of berries, the bearing wood from each section of row devoted to the experiment, including the checks, was cut out after the harvest, bound into bundles and weighed. The computations rendered possible from the data thus secured appear in the following table:

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* The fruit and foliage of the Tyler raspberry were practically destroyed by the fungicides.

Table showing the results of treatment of raspberry and blackberry for Septoria.

	Sprayed with—	Yield of berries.	Weight of bearing wood.	Calculated yield on 100 pounds of bearing wood.
		Quarts.	*Pounds.*	*Pounds.*
Raspberry:				
Cuthbert (sprayed 3 times)	Bordeaux mixture	3½	10.5	33.33
	Copper carbonate	14	15.5	90.32
	Mixture No. 5	16¼	22	73.86
	Check	21¼	14.5	146.55
Gregg (sprayed 4 times)	Bordeaux mixture	2.4	12.5	19.2
	Copper carbonate	4⅝	16	29.12
	Mixture No. 5	3¾	13	28.84
	Check not sprayed	16¼	15.3	106.21
Blackberry:				
Stone's Hardy (sprayed 6 times)	Bordeaux mixture	17	19.5	87.02
	Copper carbonate	19¼	18	106.94
	Mixture No. 5	14¼	14	101.79
	Check	13¾	16.5	83.33
Ancient Briton (sprayed 6 times)	Bordeaux mixture	10¾	8.25	130.3
	Copper carbonate	17¾	8	221.87
	Mixture No. 5	16¼	8.125	200
	Check not sprayed	18¼	9.5	205.48

From the table it would appear that the yield of raspberries was seriously injured by all of the treatments, and especially by the Bordeaux mixture and Mixture No. 5, but that the crop of blackberries was somewhat improved by the use of the copper carbonate. In the Stone's Hardy, the yield seems to have suffered from none of the treatments, and to have been improved by both the copper carbonate and Mixture No. 5, while in the Ancient Briton the crop seems to have been injured by the Bordeaux mixture.

The cost of making the individual treatments in the experiment upon the raspberry and blackberry would not differ much from that of spraying one apple tree with each of the fungicides. An estimate of the cost in the case of the copper carbonate may therefore be made by referring to the paragraph giving the cost of the apple sprayings. The cost of the Bordeaux mixture would be slightly greater than that of the ammoniacal copper carbonate.

From this experiment it is evident—(1) That the foliage of the raspberry is delicate, and can not endure applications of a corrosive nature; (2) that the foliage of the blackberry though more resistant than that of the raspberry is more susceptible to injury than that of the apple; (3) that none of the treatments given are to be recommended for the raspberry, and that of the materials used only the copper carbonate solution can be pronounced beneficial in the case of the blackberry.

EXPERIMENT IN TREATING THE POTATO ROT.

The only fungicide tested in this experiment was the Bordeaux mixture prepared as noted in the preceding article. The plat selected for the experiment included about half an acre of ground nearly in the form of a square, and was planted with snowflake potatoes May 31, the seed being placed in hills 3½ feet apart each way.

Five rows extending through the center of the plat in each direction were staked off as a check area, the four corner plats thus separated being subjected to the treatment. The SW. plat was treated with the Bordeaux mixture at its full strength; for the NE. plat the mixture was diluted about one-fourth; for the SE. plat about one-third, and for the NW. plat about one-half.

The first treatment was given July 3d, at which time the plants were 3 to 15 inches high, and apparently entirely healthy. Other treatments were given July 14 and 25, August 6 and 19, and September 2.

More or less of the mixture was visible upon the vines at all times after the first spraying until the crop was harvested. At the time of the fifth spraying (August 19) it was evident that the treatment was bearing fruit, as the foliage of the check rows

was turning yellow and in spots becoming brown and apparently dying, while that of the treated portions was still fresh and green. At the last spraying (September 2) the effect of the treatment was still more marked, the vines in the check rows being mostly dead or severely blighted, while very little of the blight was visible on the treated plats.

During my visit to Mr. Hatch's place in the latter part of September, the check rows were conspicuous by their brown and dry appearance at a distance of several rods from the field, while the vines in the treated areas were still for the most part green and growing. A frost occurred September 28, which destroyed most of the surviving foliage. October 9 to 15 the potatoes in the various plats were dug, assorted, counted, measured, and weighed. The numerical data appear in the following table. The results of the treatment appear more clearly from the graphic diagram (Fig. 3), in which the white portion represents the yield of merchantable potatoes, and the diagonal lines that of the small potatoes.

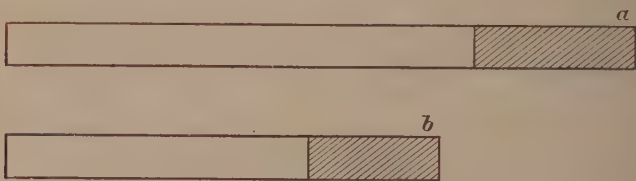

FIG. 3.—*a*, after six treatments; *b*, not treated.

Plat.	No. of hills.	Merchantable yield.		Total yield.		Yields calculated to a uniform number of hills.			
						Merchantable.		Total.	
		No.	Weight.	No.	Weight.	No.	Weight.	No.	Weight.
			Pounds.		*Pounds.*		*Pounds.*		*Pounds.*
Northeast corner	321	2, 255	835	6, 815	1, 133	2, 669	988	8, 068	1, 310
Northwest corner	287	2, 530	871	6, 455	1, 102	3, 350	1, 049	8, 547	1, 459
Southeast corner	340	2, 176	903	7, 462	1, 320	2, 432	1, 009	8, 340	1, 475
Southwest corner	343	3, 075	1, 127	6, 905	1, 367	3, 407	1, 249	7, 650	1, 514
Check	380	2, 125	698	6, 200	1, 000	2, 125	698	6, 200	1, 000

The unequal number of hills in the different plats arose from two causes, viz, the whole area was not quite regular in outline, and as the ground was a little sloping, the heavy June rains washed out some hills in places. The numbers recorded in the table represent the hills that matured their crop, as determined by counting before the potatoes were dug.

As the check rows traversed the whole planted area in both directions, we are justified in assuming that they represented an average of the whole plat so far as the conditions of soil and culture were concerned, and that any difference in the yield of these rows, and that of the average of the four treated plats, when calculated to a given number of hills was due to the treatment. In other words, had each of the four treated plats contained the same number of hills as the check rows, the aggregate yield from them would have been, without treatment, approximately four times as much as that from the check rows. Considering the yield of merchantable potatoes, then, the four treated plats would have yielded without the treatment 4 × 698, or 2,792 pounds, whereas they actually yielded 4,295 pounds, or an increase, presumably due to the treatment, of 1,503 pounds, a fraction over 25 bushels. From the figures, it would appear that the applications to the southwest plat, in which the fungicide was used at its full strength, were most effectual, and that for the potato, the Bordeaux mixture should not be diluted.

The cost of the treatment was approximately as follows:

69 pounds copper sulphate, at 9 cents	$6.21
24 hours' labor, at 15 cents	3.60
Lime and labor of preparation	.50
Total	10.31

from which it appears that the treatment, though made with a small hand force pump, and in the most thorough manner, was more than compensated for by the increased yield secured.

It should be added that none of the potatoes were decayed at the time of digging, and that there were no indications that the blight which so injuriously affected the foliage of potatoes the past season on the check rows of our experimental plat, and throughout southern Wisconsin, was connected in any way with the potato-rot fungus, *Phytophthora infestans.* But whatever the affecting disease was, it is evident that the treatment proved a remedy for it.

Mr. Hatch states that the Colorado potato beetle *Doryphora decemlineata* did not attack the potato plants in the treated plats, an additional point of some value in favor of the treatment.

DESCRIPTION OF PLATE.

PLATE IV.

Fig. 4. The value of mixture No. 5, as compared with that of ammoniacal copper carbonate.
- *a*, mixture No. 5, sprayed eight times.
- *b*, ammoniacal copper carbonate, sprayed eight times.
- *c*, check, not sprayed.

Fig. 5. The value of ammoniacal copper carbonate as compared with Bean's sulphur powder.
- *a*, ammoniacal copper carbonate, sprayed six times.
- *b*, Bean's sulphur powder, sprayed six times.
- *c*, check, not sprayed.

Fig. 6. The value of copper carbonate suspended in water as compared with that dissolved in ammonia.
- *a*, suspended copper carbonate, sprayed six times.
- *b*, ammoniacal copper carbonate, sprayed six times.
- *c*, check, not sprayed.

Fig. 7. The effect of spraying before bloom—Fameuse.
- *a*, sprayed once before bloom, three times after.
- *b*, sprayed four times after petals had fallen.
- *c*, check, not sprayed.

Fig. 8. The effect of spraying before bloom—Canada Peach.
- *a*, sprayed twice before bloom, and twice after.
- *b*, sprayed four times after bloom.
- *c*, check, not sprayed.

Fig. 9. *a*, eight treatments with ammoniacal copper carbonate.
- *b*, six treatments with ammoniacal copper carbonate.
- *c*, four treatments with ammoniacal copper carbonate.
- *d*, two treatments with ammoniacal copper carbonate.
- *e*, no treatment.

Additional Notes by Mr. Hatch.

EXPERIMENTS IN TREATING APPLE SCAB.

(*Fusicladium dendriticum.*)

It is my opinion that the first spraying for the apple scab should be made much earlier than the time usually selected for the first spraying for the codling moth. The foliage is then pretty well formed, and the past season we found well developed scab spots upon the leaves at that time. The few scab spots found later in the season that appeared to have been killed by the treatment warrants the conclusion that the chief benefit of spraying comes through the destruction of the spores that have gained lodgment upon the fruit and foliage. The results in the case of the trees treated before blooming also points in this direction. I think it possible that a treatment before the buds have commenced to expand would be productive of much good.

The extremely heavy rains of June and the first part of July rendered the season very unfavorable for the work and resulted in loss of the benefits of spraying my main orchards for both apple scab and insects. Still, by persistent effort I think we have some valuable results. At least we have done all possible to make them successful, and our thanks are due to Professor Goff for his aid at various stages of the work. My loss from apple scab has been very serious, not only in fruit but also in foliage, and the magnitude of its injury warrants still greater efforts in combatting it.

We found Mixture No. 5 very persistent upon the foliage, but apparently too strong in ammonia. Its caustic effects were so apparent that for some of the later sprayings we reduced the quantity one-third. The solution of carbonate of copper, although diluted 100 parts with water, had similar effects, and I would suggest that it may possibly be found equally efficient if diluted even 200 times. We used strong ammonia (supposed to be 22° Baumé) to make a saturated solution (about 1 ounce to 1 quart). In using carbonate of copper in water alone I think we used too little. There would have been no harm to the foliage if used several times as strong, nor indeed is it likely to prove injurious in any degree.

The treatment in the case of the blackberry and raspberry was for *Septoria rubi*, a small fungus causing the foliage to turn yellow, wither, and fall before the fruit matures. Here again earlier treatment seems to be advisable. The first spraying was when leaves were about full grown. At this time Septoria showed plainly on the leaves, and it is our opinion that preventive treatment is more desirable than curative. The first Bordeaux mixture used was made with 6 pounds of copper sulphate and 4 pounds of lime. This injured the foliage so much that we reduced it with water one-third, and afterwards used 6 pounds of lime in place of 4. The other fungicides also proved injurious to the leaves, and we concluded that the black raspberries especially are very tender in foliage. The Bordeaux mixture proved especially bad, not only in injury to the foliage, but also in adhering to the fruit so as to make it unfit for use. It should be mentioned that the raspberries treated were each side of a row of blackberries that were last year destroyed by the orange rust. Still no rust was visible this year on either the raspberry or blackberry bushes that sprouted where the row was removed. The loss by Septoria this season has been quite large.

THE POTATO EXPERIMENT.

Rot has not been prevalent here for a few years. In order to secure its development for treatment we ordered a barrel of seed from Ohio, where rot was plenty last year, but failed to secure any affected potatoes. We then planted with such seed as we had, mostly Snowflakes, with a few mixed kinds. To still further assure rot we planted late, May 31, and supplemented 4 rows along one side of the plat which we covered with a fork full of sheep manure in each hill. The heavy rains not only washed out some of the potatoes, but so compacted the soil as to make them very slow in coming up and getting a start. The last of July and the month of August were extremely dry and no rot appeared. Even the manured rows were sound and

good, no Phytophthora being visible anywhere. There was, however, a blight of the foliage that has proved very general and widespread throughout all this region. The leaves turned yellow in spots, then brown, and the entire vines died long before the growing season was completed. The check rows in the experimental plat and my own potatoes elsewhere on my farm were all seriously affected with this blight. By the first of September this was so emphatic that the check rows were easily selected from the plat, the treated vines showing mostly bright and green when frost came. Still there was an occasional hill among the treated vines showing the same trouble as the untreated, but not in so large a degree.

We had expected to use our field pump in a large barrel mounted on farm trucks with the Vermorel nozzle attached to the hose, but found that we could not go over the plat and make the turns with the team without running into the potatoes and injuring them. So we abandoned its use and did the entire work by hand with our Nixon Climax pump, using a No. 3 Nixon nozzle. We overcame the difficulty of clogging by having a piece of brass wire strainer cloth soldered over the lower end of the suction pipe. This had a mesh finer than the orifice of the nozzle and was a complete remedy for clogging, not only in using the Bordeaux mixture, but also in all other spraying done by us.

Another variation we made was in using the Bordeaux mixture. We hauled out for each treatment a barrel containing 12 pounds each of copper sulphate and lime and 44 gallons of water properly mixed to make the regular Bordeaux mixture. We also took another barrel of clear water. At the beginning we stirred the mixture, allowed it to settle a minute, and took out two or three pailfuls to use. After using enough for the southwest corner, clear water was added to the large barrel, and so on until the plat was gone over, 70 to 75 gallons in all being used. This would give about the following strength nominally to each plat: Southwest, full strength; southeast, two-thirds; northeast, three-fourths; northwest, one-half. There was, however, about the same appearance in the consistency of the liquid used for each plat on account of the sediment in each lot being about all the water would carry, and the appearance of the vines after spraying was the same in each plat. From the time of the first spraying the application was always more or less visible. I thought there was a difference in the vigor of the vines in favor of the northeast corner, but suppose the figures as tabulated by Professor Goff will show this matter clearly. At any rate I venture the opinion that it may be well to experiment with Bordeaux mixture in a more diluted form than the regular formula.

Another apparent result of the spraying was in regard to the Colorado potato beetle. I found it necessary to go over the check rows with London purple the second time, but the treated part was almost entirely free from them. It would thus appear that where the mixture is used for rot and blight it may also be efficient as an insecticide.

DISEASES OF THE ORANGE IN FLORIDA.*

By Lucien M. Underwood.

The following notes on the diseases of the orange in Florida were made during a visit to that State during the months of February, March, and April of the present year (1891). They consist simply of the results of observations in the field and evidence collected from intelligent growers in various portions of the State. The orange groves and methods of cultivation and treatment were observed in the following counties: Brevard, Citrus, Hernando, Lake, Manatee, Marion, Orange,

* Professor Underwood collected the information embodied in this report while acting as special agent for the Division of Vegetable Pathology.—[B. T. G.]

Pasco, Polk, St. John's, Volusia. Nine other counties were traversed and visited during the winter.

GENERAL CONSIDERATIONS.

(1) The cultivation of the orange in America is of comparatively recent origin. The very oldest groves in Florida do not reach a half century, and there are few groves of even half that age. As the orange trees do not usually show disease until they reach full bearing it is natural to suppose that the absence of diseases in certain localities is due to the fact that the groves are too young to show the effects of disease; it is also natural to expect that as the groves grow older certain diseases will become more and more prevalent. Certain it is that the greatest ravages of disease are to be seen among the oldest groves.

The fact that the orange industry is comparatively a new one is the cause of much injury to many orange groves because of lack of experience in cultivation and fertilization.

The method and time of cultivation are an important matter for orange-growers. Judging from observation in many places there is more of a tendency in the direction of overcultivation than the reverse. Moreover, the method, time, and extent of application of fertilizers are exceedingly important, as well as the adaptation of the kind of fertilizers used to the varying conditions and necessities of the soil. Much injury results to groves by (*a*) overcultivation and (*b*) unfortunate treatment with fertilizers in quantity, quality, and method of application.

Unfortunately for the orange-growers the State experiment station is located too far north to be within the belt of profitable orange-growing. There is pressing need of more organized experimental work in this direction in order to attain the best method of treatment and thus avoid many of the causes of injury from the sources above mentioned.

(2) There exists in Florida a great diversity of soil and a large proportion of the State is not adapted to orange-culture. In fact, only a few favored localities are likely to long maintain their reputation for the cultivation of citrus fruits. Many groves now planted will never reach maturity, or, if so, will require more artificial fertilizing to mature a crop than will be profitable to the owner. One source of disease is the starved condition of certain groves, owing to natural deficiencies of soil, for weakened vitality increases the liability to become the prey of organic troubles.

(3) Many orange groves were started in regions where the trees are subjected to low temperature during the winter months. Even where frosts do not kill the young twigs outright the vitality of the tree is much weakened by the effect of either a cold snap or continued cold weather, and consequently more likely to be preyed upon by organic diseases. The great frost of 1886 and the unexpected late frosts of 1890 and 1891 (occurring in March in the former and in April in the latter year) have left their marks on the orange groves in many quarters, not

merely in external and visible manifestations, but even more in the impaired vitality of the orange trees. It may be added that some of the effects of frosts are not infrequently confounded with diseases of a very different nature.

(4) The exceedingly dry season of the past year has also left its traces in the impaired vitality of many trees, and the uncertainty of rain and the liability of drought are inducing many to introduce irrigation plants, which in the hands of careless cultivators are likely to become a source of harm as well as good.

CLASSIFICATION OF DISEASES.

The diseases affecting the orange may be arranged under four groups:

(1) Those resulting from climatic conditions and environment, as frost, drought, natural defects of soil, natural excesses of soil constituents, and undue moisture.

(2) Those produced by insect pests. Although this group is outside the limits of this paper, we may mention in passing that during the present season the long scale,* the red spider,† and the rust mite‡ are apparently the most troublesome pests of this nature, but the first is likely to be kept in check by the lady bugs (*Coccinellidæ*), the second will succumb to spraying, and the third may be held in check by the character of the cultivation.

(3) Those due to injurious cultivation and fertilization.

(4) Those due to the agency of parasitic fungi and bacteria.

Only the diseases of the last two groups will receive notice here. The diseases noticed during the early season of 1891 were as follows:

I. Die-back.
II. Foot-rot. } Probably caused by improper cultivation or fertilization.
III. Blight. Possibly caused by bacteria.
IV. Scab.
V. Leaf spot. } Caused by parasitic fungi.
VI. Sooty mold. Caused by a saprophytic fungus.
VII. Leaf glaze. Caused by a leaf lichen.

I.—DIE-BACK.

(1) *Nature of the disease.*—This disease first makes its appearance in strong shoots of the season in the form of pustules or blisters on the stems near the point of attachment of the leaves. These when opened appear to contain a reddish, gummy substance. In later stages of the disease these pustules rupture and extend in cracks along the twig, the reddish gummy substance coming to the surface and spreading until the whole twig becomes diseased and finally dies back to the main stem. This peculiar and characteristic effect gives rise to the appropriate, if not elegant, popular name of the disease. In badly infected trees most or all of the fruit falls when young; that which matures is likely to be mis-shapen and discolored. There seems to be no evidence that the disease is contagious.

Trees that have been affected with die-back and have recovered from its effects will reveal it years afterward in the sudden bends of the

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* *Mytilaspis gloverii*, Pack. † *Tetranychus telarius*, L. ‡ *Typhlodromus oleivorus*, Ashm.

smaller branches. The main twigs die and the smaller side branches, having taken up the growth and received the nourishment intended for the main branch, become larger and appear as if the branches had taken sudden turns in the process of their growth.

(2) *Distribution.*—The disease does not seem to have occasioned much alarm, although it appears to be widespread and liable to occur whenever the causes that produce it are present. Bad cases of it occur in various portions of the orange belt visited.

(3) *Causes.*—It is the almost universal testimony of growers that excess of nitrogenous fertilizers will either produce the die-back, or, what is equivalent, will produce the conditions under which the disease will develop. The evidence collected in the field bearing on this point justifies a similar conclusion.

Among others the following conditions, under which the disease is prevalent, point to this source of the difficulty:

(*a*) Proximity of orange trees to horse stables or piles of horse manure.

(*b*) Proximity of trees to houses where, with the carelessness induced by the porous sandy soil, household slops are thrown indiscriminately.

(*c*) Proximity of trees to chicken pens. The habitual roosting of poultry in orange trees is likewise liable to induce the disease. In several groves visited it had been the former custom to use portable chicken pens which were moved from tree to tree in order to secure a natural guano in the place where it was supposed to be most beneficial. In all these cases the practice had been stopped because of the die-back that appeared in every tree thus fertilized. The trees had not recovered at the time of our visit.

(*d*) The excessive use of blood and bone or other commercial fertilizers rich in nitrogenous elements seems to stimulate the disease.

(4) *Remedies.*—Almost as general as the belief in the cause or occasion of this disease is the belief that the most effectual remedy is to let the affected trees entirely alone. The cessation of cultivation and heavy fertilizing will remove the disease even in bad cases. We noticed trees, which two years ago produced no fruit, because of the severity of the disease, that were sufficiently restored to produce a half crop or more during the present season, with no other treatment than that above mentioned.

II.—FOOT-ROT.

(Gum disease, *mal di goma.*)

(1) *Nature of the disease.*—This disease has long been known in Europe and has also given rise to some investigations in this country. Mr. A. H. Curtiss has quite fully described the disease, and we quote from his description:

The prominent symptoms are exudation of a gummy or sappy fluid from near the base of the trunk, and decay of the bark in that region and of the roots below. The flow of gum and attendant decay of the tree extend upward and in a lateral direction until the tree is girdled, also penetrating successive layers of wood. In some cases gum exudes from cracks in various parts of the trunk or even on the branches, and in others the decay progresses without emission of gum. Attendant or premon-

itory symptoms are excessive and rather late blooming, the flowers being small or mostly unfruitful, and arrested and unnatural development of the foliage, which becomes yellow and drops.*

We could gain no evidence of its contagious nature. A résumé of information concerning this disease has been already published from the Department,† and only such additional or conflicting information as we have gathered will be here given.

(2) *Distribution.*—Like the preceding disease, foot-rot is not confined to particular localities, but has a wide distribution. Bad cases occur at various points throughout the orange belt; it is more serious in the older trees, rarely appearing in trees less than 12 or 15 years old. In many places, especially in young groves, it is just beginning to appear, but has not yet attracted the attention it merits, for as groves grow older and present methods of fertilization continue it is likely to prove still more injurious and destructive. Contrary to popular and published opinion, it is not confined to sweet seedlings. We have seen bad cases in large sour stock budded 2 or 3 feet above ground, in the grape fruit, and even in the lemon.

(3) *Causes.*—Nothing has come to light that settles upon any definite cause for the disease. From all that can be learned, however, it would seem that the cause is to be looked for in the defects of cultivation and fertilization rather than in any bacterial or fungous parasite. Some maintain that it is of a similar nature to die-back and is occasioned and cured by the same treatment. There is no visible proof of this statement and no facts to illustrate any genuine cures, as in the case of the former disease; it is doubtful if more than temporary relief can be gained by this method, for when the disease is well established in the tree it is almost certain to girdle it in time in spite of any treatment yet discovered.

(4) *Remedies.*—Sweet seedlings affected by this disease are frequently assisted by planting one or more stands of sour nursery stock near the root and budding several branches into the trunk above the infected portion. This at best can furnish only temporary and partial relief, for the disease is likely to spread too rapidly in the main trunk to allow the budded support time to furnish sufficient nourishment for the tree before its own supply is cut off, or the sour stocks are likely to be ultimately affected themselves.

Exposing the crown roots is another method of treatment in favor in certain parts. As a preventive it is more likely to be successful than as a cure, but it is doubtful if this method will be of any permanent value and there is some liability of its proving an injury to the trees in other ways. One method of treatment connected with the manner of cultivating the trees seems worthy of trial: Cultivate sparingly, fertilize more sparingly, and apply no fertilizer nearer than 6 or 7 feet

* Bulletin No. 2, Florida Agr. Experiment Station, 1888.

† U. S. Department of Agriculture, Botanical Division, Bulletin No. 8, pp. 51–54 (1889).

from the trunk of the tree. In addition a study should be made of the relative adaptability of the various fertilizers to the particular soil. This is properly the function of public experimenters, but much can be accomplished by individuals if sufficient care is exercised. In one of the finest groves visited the principal fertilizer used consisted of decaying vegetable rubbish piled between the rows of trees. Weeds were allowed to grow in the intervening spaces thus covering the light-colored soil, and preventing much of the undue reflection of light and heat that is so common where clean culture is practiced.

III.—BLIGHT.

(Leaf curl, Wilt, Go-back.)

(1) *Nature of the disease.*—The leaf blight, leaf curl or leaf wilt, as it is variously called, first makes its appearance on certain branches, and may be recognized by the curled or wilted appearance of the leaves, which also turn a sickly yellowish color and after a short time drop from the tree. The twigs at the ends of the branches also die, and if new ones appear they soon present the same sickly hue; the bark, especially on the upper side of the branches, becomes "hide-bound," and later splits open on either side, leaving a dead space between the ruptures. The fruit grows smaller, but is otherwise not affected. Gradually other branches become infected, and if the tree is left to itself it finally dies down to the root. As the disease progresses new shoots constantly make their appearance below the infection, appearing robust at first, but as the infection descends they too become wilted, and finally those only appear healthy that spring from the root. If the tree is vigorously pruned at the first appearance of the disease and well fertilized, it will apparently recover, but after a little will relapse or go back to its former condition. This peculiarity of the disease has given rise to to a popular name which it does not seem desirable to perpetuate.

The disease does not seem to attack trees before they reach maturity, or before they are 10 or 12 years old. When one tree becomes attacked, adjoining trees, either during the same season or more likely during the following season, will be affected, so that the diseased trees appear in groups. Sporadic cases occasionally occur, but the above condition is so nearly universal as to make it extremely probable that the disease is contagious.

(2) *Distribution.*—Bad cases of this disease are found as yet in only a few localities where the orange groves have long been established. While it is evidently not a new disease its ravages have only recently extended sufficiently to give alarm to cultivators. All things considered, this disease is the most dangerous that has yet appeared among the orange groves, and a study of its causes and cure demands immediate attention.

(3) *Causes.*—Nearly as many causes are assigned for the disease as there are cultivators whose groves are affected by it. Some assign it

to the decay of tap roots and others to the tap root coming in contact with hard pan or underlying rock formation. To test this the tap roots of certain infected trees were exposed and examined. The tap root extended about 4 feet in one case and between 8 and 9 feet in another, and in every case had not extended below the sandy soil and were apparently healthy. Some attribute it to overbearing; still others, to some peculiar oiliness of the soil which prevents it from becoming thoroughly wetted. In regard to this we may state that, while the surface is usually very dry in most locations, the subsoil in all the examinations made on infected trees was wet and in one case water accumulated in the excavation at a level only a foot below the extremity of the tap root. Others liken the disease to pear blight. It differs, however, from that disease, in extending to parts of the same tree much more slowly and in spreading to trees adjacent to the center of the infection only after a considerable time, usually after the interval of a season's growth.

From all the evidence gathered in the field we incline to the belief that this disease is bacterial in its nature, and while the evidence is so scanty as only to create an *impression* it is strong enough to recommend investigation in the direction of this theory. With sufficient time (because the action of the disease is rather slow) a skilled experimenter could doubtless prove its nature to be bacterial, if such be the case. The other causes assigned and probably still others connected with the methods of cultivation, and possibly some climatic conditions, may indirectly encourage the spread of the disease by furnishing conditions under which the tree can not successfully resist the attack of the disease. It is well known, but too often not sufficiently taken into account, that certain physiological conditions render trees subject to ravages of disease, just as among men and other animals, and often a disease may be warded off by keeping the tree in the proper condition of vitality, more easily than it can be cured if once the disease has taken possession of it.

(4) *Remedies.*—There is little to say under this head at present. The following methods have been tried, but with indifferent success:

(*a*) Prying up the trees, so as to raise the roots from the "hard pan."
(*b*) Cutting back the branches and fertilizing heavily.
(*c*) Trimming off affected branches and burning them.
(*d*) Trimming back branches, trenching at a distance of six or eight feet from the tree, so as to cut back roots proportionally, followed by heavy fertilizing.

In addition to the above, a rather unique method of treatment was applied by the advice of a dealer in a commercial fertilizer "specially adapted to the cure of diseased trees." This consisted of cutting back all the branches of the tree to within two or three feet of the trunk, smearing the cut ends of the branches with coal tar as a preventive against the ravages of the "crown borer,"* and then smearing the entire

* *Elaphidion inerma* Newman.

trunk with a paste made of clay, lime, sulphur, and "chips" (dry cow manure). At the time of our visit the application had only recently been made, so we were not able to see the results. It can hardly be expected that such a treatment will prove beneficial. The same dealer claims to have cured a number of trees in that way, but at the time of our visit to his place he was absent from home and we were thus unable to sift the evidence.

IV.—SCAB.

(1) *Nature of the disease.*—This disease first makes its appearance in the form of whitish or cream-colored spots, more commonly on the under side of the leaf but often on the upper side and occasionally on the young twigs and fruit. Those on the leaf are often accompanied by a depression or pit on the opposite side. These spots grow larger and often coalesce; ultimately they turn dark, and if abundant the leaf becomes badly curled, twisted, or otherwise distorted and more or less covered with the wart-like eruptions which the disease has developed.

(2) *Distribution.*—The disease is widespread; in a few localities it does not seem to be regarded as anything serious. In other localities, where it is more abundant, it is becoming the source of much alarm. It is not confined to young trees, but attacks equally young and old stock. While more abundant on the wild orange it is by no means confined to it, nor even to sour stock. We saw it on wild orange trees very commonly, on grape fruit and lemon trees frequently, and on sweet orange trees rarely.

(3) *Causes.*—Prof. F. L. Scribner, who made a study of this disease in 1886,* attributed it to a parasitic fungus (a species of *Cladosporium*), whose growth in the tissues of the leaf produced the distortions and saps its vitality. Our own observations confirmed these conclusions.

(4) *Remedies.*—In the paper above alluded to Prof. Scribner makes the following recommendations for spraying mixtures: (*a*) A solution of potassium bisulphide, one-half ounce to the gallon; (*b*) liquid grison; (*c*) one-half pint carbolic acid and 1 pound of glycerine added to 10 gallons strong soap suds.

We could not learn that these remedies or any other treatment had been attempted in any of the orange regions visited.

V.—LEAF SPOT.

(1) *Nature of disease.*—On certain leaves of the orange, both wild and sweet, faded spots appear, varying in shape, but mostly rounded or oval, and in size from one-eighth of an inch to an inch in diameter. As the disease progresses, these spots become grayish brown and dead, and covered on one or both surfaces with a series of minute black points, which contain the fruit of the fungus, which is the cause of the disease.

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* Bulletin Torrey Botanical Club, XIII, 181-183 (Oct., 1886).

(2) *Distribution.*—This disease was found at only one point in Lake County. Dr. Martin found it in 1886 at Green Cove Spring. It does not seem to be widespread nor at present of much importance, but is recorded here that attention may be called to it, so that its nature may be known and its progress watched.

(3) *Causes.*—The cause of this disease is a parasitic fungus (*Colletotrichum adustum*, Ellis)* which draws the nourishment from the leaf it inhabits. It belongs to a group of fungi that are known to be imperfect forms, and are supposed to be a phase of growth in the life history of some mature form of fungus. The particular form of which this species is a phase of growth is not known nor even suspected. Its connections are to be looked for among some of the many species of ascomycetous fungi which inhabit decaying vegetable matter, and for this reason are supposed by the uninformed to be of no economic interest.

VI.—SOOTY MOLD.

(1) *Nature of the Disease.*—The leaves of certain trees badly affected with some kind of scale insects become covered with a sooty layer, which is of a dark drab or dirt color early in its growth and finally becomes sooty black. The layer thus formed is only loosely attached to the smooth surface of the orange leaf and frequently comes off in patches.

(2) *Distribution.*—This disease does not appear to be very widespread on the orange trees in Florida† and the material collected was young and immature. We found it, however, more abundant on *Magnolia fœtida*, *Smilax* sp., and other shrubs which were abundantly affected with scale insects.

(3) *Causes.*—In 1876 Dr. W. G. Farlow published an elaborate paper‡ giving a full account of this disease as affecting the orange and olive trees of California, and referring it to a fungus (*Capnodium citri*, Berk. & Desm.) which feeds on the honey dew produced by the bark lice. While the fungus draws no nourishment from the orange leaves themselves it must, if abundant, seriously interfere with the process of assimilation and therefore be regarded as injurious.

(4) *Remedies.*—In the paper above mentioned, spraying with a strong solution of alkali soap is recommended. The disease has not yet made sufficient progress in Florida to demand much treatment, and with the natural enemies of the scale insect to check their development is not likely to prove a serious difficulty.

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*Described as *Phyllosticta adusta*, E. & M., but Mr. Ellis (*In litt* 16 May, 1891) refers it to *Colletotrichum*.

† At Los Angeles, California, in 1886, we saw this disease in great quantity, entirely covering the leaves in some of the orange groves. With the disappearance of the scale insect the disease will disappear likewise.

‡ Bull. Bussey Inst. I, 404–414, 1876.

VII.—LEAF GLAZE.

The disease to which we have given the above name makes its appearance in the form of grayish flattened patches on the upper surface of the leaves. These are small and often clustered at first, but soon coalesce and become of considerable size. The spots are due to the growth of a lichen (*Strigula* sp. probably *S.complanata*, Fee.), which draws no nourishment from the leaves but, like the preceding disease, must interfere in a measure with the assimilation of the plant. Many other lichens and some scale mosses (Hepaticæ) are likely to accumulate on the trunks and branches of the orange trees where there has been careless management of the groves. Their presence is a disadvantage to the tree as harboring places for vermin, but they are much less likely to have any influence over the physiological functions of the tree than the present species. We are not aware that attention has been called to this source of trouble before in relation to the orange trees nor that any methods of treatment have been recommended for arresting the growth of the lichen. Tuckerman reports this species on Magnolia, and we found it abundant on Magnolia leaves in Lake County. The spots of growth on the orange were small and immature at the time of our visit, but as the rainy season advances they are said to increase in extent and often spread over considerable portions of the leaf.

OTHER FUNGI GROWING ON ORANGE TREES.

Only a few species of saprophytic fungi were found among the orange groves, growing on dead or dying trunks and on dead limbs and twigs. The two species of *Hypochnus*, whose systematic position is uncertain, grow on the trunks of living trees that are usually more or less covered with lichens and Hepaticæ. The following were found, some not being in a condition to be specifically identified: *Schizophyllum commune*, *Polyporus* sp., *Corticium* sp., *Hypochnus albo-cinctus*, *H. rubro-cinctus*, *Xylaria* sp., *Diatrypella citricola*, Ellis, n. sp., *Macrosporium*, sp., and some others of still more doubtful relations.

PEACH BLIGHT.

Monilia fructigena, Persoon.

By Erwin F. Smith.

(Plates V and VI.)

This note is for the purpose of calling renewed attention to the destructive action of *Monilia fructigena* upon the branches of the peach. It will serve to record some new facts and to correct one or two assumptions which found their way into a previous paper * without sufficient warrant.

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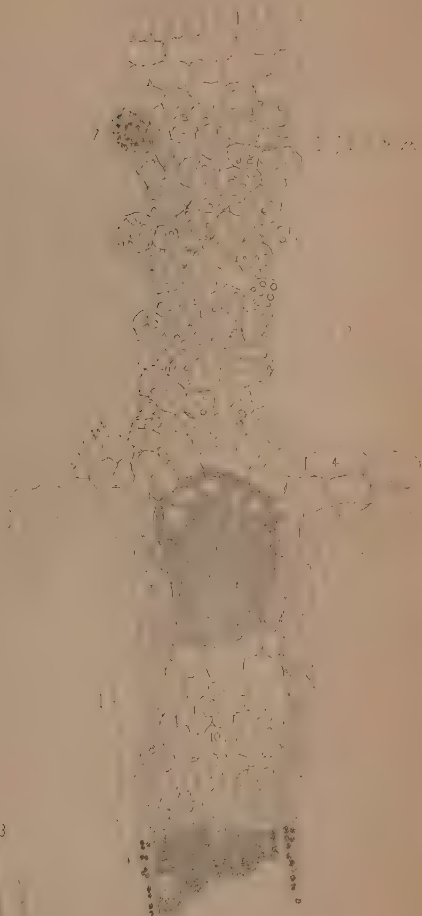
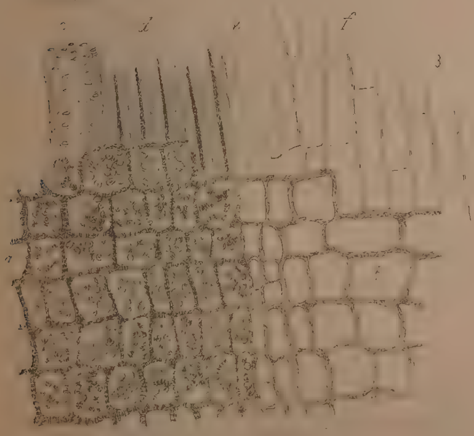
* Journal of Mycology, vol. v, No. 3.

Smith on Monilia Fructigena.





SMITH ON MONILIA FRUCTIGENA.

The vitality of the conidia is much greater than I had supposed. In one instance roll cultures from dry material a year old gave results, although only a portion of the conidia germinated. Spores from other samples failed to grow. More tests will have to be made before we have anything like an accurate measure of the vitality of the conidia, but it is probable that these alone are sufficient to tide the fungus over winter. There is, however, no question as to the existence of a resting mycelium within the mummified fruits. The sudden general appearance of the blight on the Delaware and Chesapeake peninsula this spring is a matter of special interest in connection with the fact that there was no twig-blight and no rot of the fruit in 1890. There was no fruit which could rot, owing to the destruction of the entire crop by spring frosts; and being in the orchards much of my time from April to November, I did not observe a single blighted twig, although anxious to collect it.

In the spring of 1891 the blight of the twigs of the peach was a common occurrence on the upper part of the peninsula, *i. e.*, in five or six counties. It attracted general attention and in Sussex County, where it was most injurious, it was named "the scald," and was very generally ascribed to the heat of the sun. In Maryland it was attributed to frosts.

Observations in many orchards showed that it appeared immediately after rain during the time of flowering, and that it penetrated *exclusively through the blossoms.* Heretofore I had supposed it capable of penetrating through the unbroken cuticle of young shoots, but such cases must be exceptional. An examination of hundreds of twigs in all stages of blight showed that every one was associated with blighted and persistent flowers. In a majority of cases the entire twig was killed, *i. e.*, the distal end beyond the point of entrance (Plate V, Fig. 1). The extremities of the twigs blighted either under the direct action of the mycelium or simply from arrested nutrition due to injuries farther down the stem. It was not difficult, however, to find cases (Plate V, Fig. 2) where only one blossom and a small portion of the adjacent stem was affected, the parts above and below remaining intact. The uniform persistence of the blossoms and the size of the twisted, withered leaves (Fig. 1) showed very clearly for many days that all the injury was done at one time. Some weeks later, under the influence of warm weather, many restricted blight spots, as in Fig. 2, took a new growth, girdling stems and wilting good-sized green leaves and fruits, but I looked in vain for new infections.

For 3 weeks following blooming the weather was dry and the blight was restricted almost wholly to stems of last year's growth. But I found a number of stems in which it had involved the growth of 1889, and saw enough to convince me that with wet weather and high temperature such cases would have been as common as in the summer of 1887, when the fungus entered the stems, by way of the rotting fruits.*

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* This method of penetration was also common in Maryland and Delaware in the *summer* of 1891, and early varieties blighted almost as badly as in 1887.

The dry weather also almost wholly prevented the fruiting of the fungus. Out of many hundred stems examined for spore tufts, during a period of 3 weeks following blossoming, I found only half a dozen. However, a microscopic examination showed the presence of mycelial threads in the tissues, and upon placing freshly gathered twigs in moist air for 12 hours many of them sent out the characteristic spore tufts of *Monilia fructigena.* By continuing this treatment another 12 hours spore tufts pushed through the unbroken bark on about 75 per cent of the stems. This experiment was repeated some days later with similar results, but a third experiment, using twigs which had been picked 4 or 5 days and were somewhat dry, gave only 2 per cent with *Monilia* tufts at the end of 24 hours. Plate V, Fig. 3, gives an enlarged view of a twig bearing fruiting tufts after 12 hours in moist air. Fig. 4 shows a conidiophore and conidia from the same.

The extrusion of gum from the vicinity of the blighted flowers was quite common (Plate V, Figs. 1*g* and 2*g*). On cutting through the bark of such twigs the vicinity of the cambium cylinder was invariably gummy, but this was less noticeable on dry twigs.

Carefully made cross sections of freshly blighted twigs were submitted to microscopic examination. The cambium and soft bast cylinders had disappeared almost completely with the formation of extensive gum pockets (Plate VI, Fig. 1). These pockets were full of the active mycelium of *Monilia.* This also penetrated into the cortical parenchyma to some extent, and to a lesser degree into the xylem. Practically speaking, the wood and pith and all of the cylinders external to the soft bast were intact. On unmagnified cross sections a zone of discoloration was visible between the wood and the bark. On magnification this was found to consist, as shown in Plate VI, Fig. 1, of a gum cavity containing mycelium and fragments of tissue and bordered by irregular dark zones, the one within composed of young wood and vessels laid down this spring, and the one without composed of remnants of soft bast and phlœm rays. The bundles of bast fibers were also changed from a glistening white to a dirty yellowish brown. Plate V, Figs. 5, 6, and 7, show mycelial threads from these cavities. It was easy to find threads overlying and interwoven with tissue. Plate VI, Fig. 2 represents the appearance of the destroyed tissues on a normal cross section; fig. 3 represents the same on a longitudinal radial section.

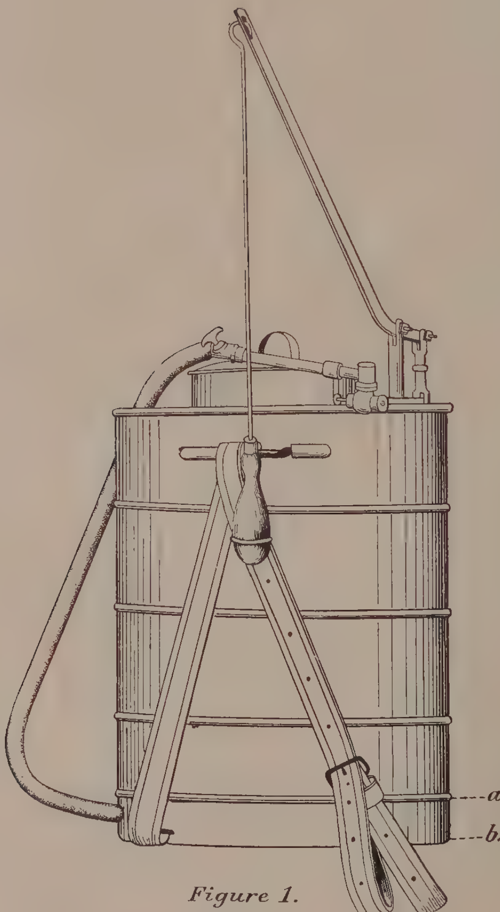


Figure 1.

GALLOWAY, ON AN IMPROVED JAPY SPRAYER.

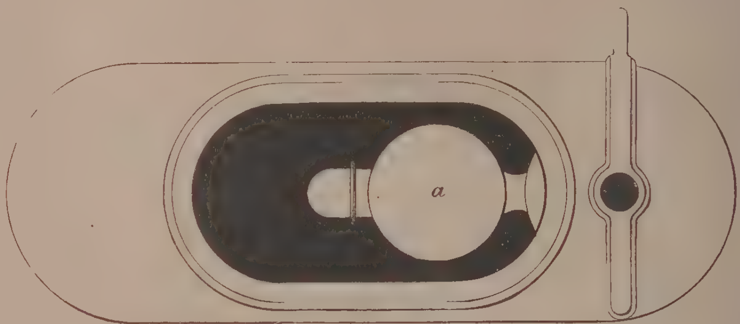


Figure 2.

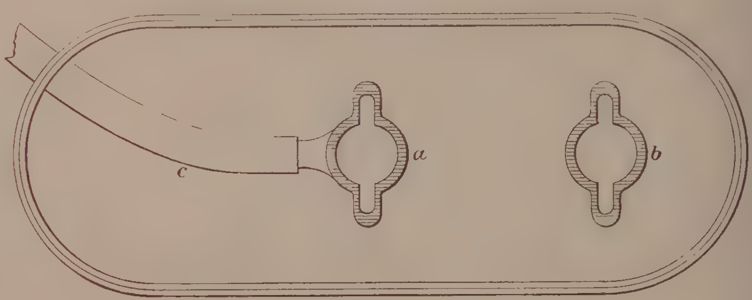


Figure 3.

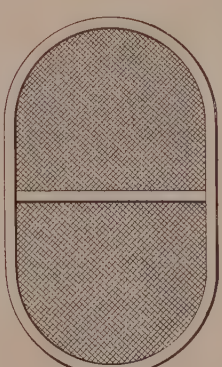


Figure 4.

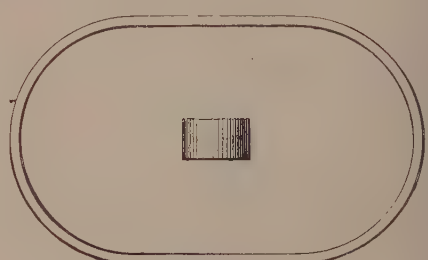


Figure 5.

Figure 6.

GALLOWAY, ON AN IMPROVED JAPY SPRAYER.

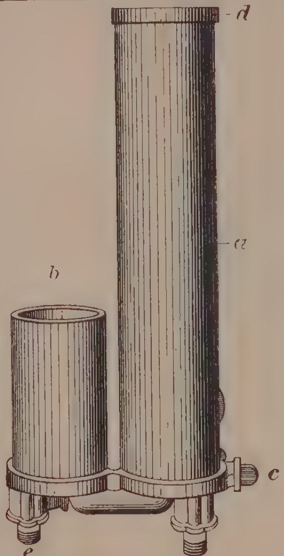


Figure 7.

Figure 8.

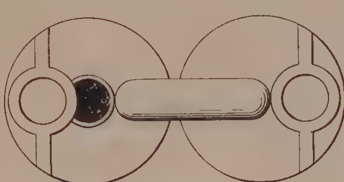


Figure 9.

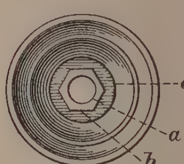


Figure 10.

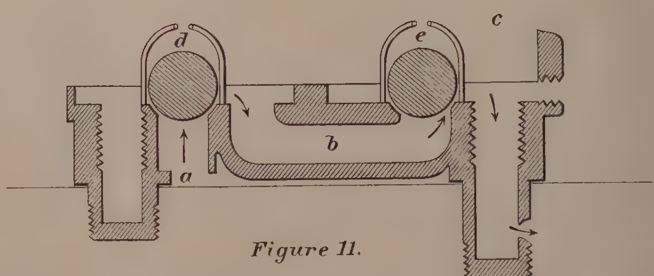


Figure 11.

GALLOWAY, ON AN IMPROVED JAPY SPRAYER.

DESCRIPTION OF PLATES.

PLATE V.—(*Monilia fructigena.*)

Fig. 1. Blighted peach stem, showing dead persistent, flowers and leaves; *g*, gum exuded near union of blighted and living portion; *w*, stem of two year's growth. Collected some days after the entrance of the fungus.

2. Peach stem collected same day as Fig. 1; *a*, withered persistent flower through which the mycelium entered the stem; *bb*, restricted area of blight, the distal end of the stem being still connected by a narrow isthmus of sound tissue with the parts below; *g*, drop of exuded gum.

3. Enlarged end of blighted stem showing conidia tufts which pushed through the bark on exposure to moist air.

4. Conidiophore and conidia from one of the tufts shown in Fig. 3.

5, 6, 7. Mycelial threads from the gum cavities of the inner bark. (See Plate VI, Fig. 1.)

PLATE VI.—(*Monilia fructigena*).

Fig. 1. Cross-section of a blighted peach stem, such as Fig. 1 of Plate V, showing a large gum cavity full of active mycelium; *p*. pith; *x*, xylem; *c*, cavity containing remnants of cambium and soft bast and hyphæ; *b*, bast bundles, *cp*, cortical parenchyma; *e*, epidermis. On the opposite side of this stem was a cavity larger than that here shown.

2. Enlarged cross-section of portion of a normal peach stem one year old, for comparison with Fig. 1. The portion destroyed is that included in the brace; (1) Epidermis; (2) subepidermal cells, usually destitute of chlorophyll, but containing coloring matters in solution, *e. g.*, reds or browns; (3) chlorophyll bearing cortical parenchyma; (4) expansion of phloem ray cells; (5) phloem ray cells separating bast bundles; (6) bast bundle—outlines of two others are indicated; (7) large cell containing a crystal of calcium oxalate; (8) phloem ray cells separating the soft bast (4, 5, and 8, destitute of starch); (9) xylem ray cells full of starch; (10) soft bast; (11) cambium; (12) xylem fibers; (13) vessels in the xylem.

3. Longitudinal radial section along the medullary ray of a stem similar to the inner part of Fig. 2, showing wood, cambium, and soft bast with an overlying portion of the ray. *a*, Cells of xylem ray gorged with starch; *b*, cells of phloem ray destitute of starch; *c*, pitted vessel; *d*, wood fibers; *e*, cambium cells; *f*, soft bast. The left part (1) is xylem; the right (2) is the inner part of the phloem, and is the portion destroyed by the Monilia. Sections from which Figs. 2 and 3 were drawn were cut from fresh material at the end of the growing season (November 1).

THE IMPROVED JAPY KNAPSACK SPRAYER.

By B. T. GALLOWAY.

(Plates VII–IX.)

Something over three years ago the Japy brothers of Beaucourt, France, designed a knapsack sprayer, which is commended by every one who has used it, for its simplicity, durability and effectiveness. This machine is used largely throughout the vine-growing region of France and a few have been imported into this country. Recently a number of improvements have been made in the sprayer which make it even more valuable, placing it, in fact, in the front rank of machines of this description. For the benefit of American small fruit and vegetable

growers, for whom this machine is especially adapted, we give below a full description of it, accompanied by illustrations.

As will be seen by consulting Plates VII–IX the machine in the main consists of a reservoir, pump, air chamber, strainer, lance, and spraying nozzle. The reservoir, with the exception of the bottom, is made of 16-ounce sheet copper and holds a little over 3 gallons. The bottom, to better withstand the strain put upon it when the pump is in use, is made of 20-ounce copper. It is further strengthened by soldering across it, inside the tank, two strips of heavy sheet copper, each 1½ inches wide and 4½ inches long. While speaking of the bottom it may be well to say that the wall of the reservoir projects in a rim beyond it a distance of 1¾ inches, as shown by the two dotted lines *a* and *b* in Fig. 1, *a* being the point where the bottom is placed and *b* the edge of the rim. Both top and bottom of the tank are soldered in and are provided in each case with two openings. The openings in the top, as shown by the black portions in Fig. 2, are for the introduction of the liquid and the piston rod, the small round opening serving for the latter purpose. The white portion *a* in Fig. 2 merely represents the top of the air chamber, which extends to within 1½ inches of the top of the tank. It will be understood, of course, that this opening, which is 4⅛ by 7⅜, is clear throughout, the top of the air chamber offering no obstruction whatever to the introduction of the liquid. Into the large opening is fitted a brass wire strainer having a number forty mesh. The strainer is shown at Fig. 4. It is made by simply soldering the brass wire already mentioned to a collar of sheet copper three-fourths of an inch in height. Across the strainer is soldered a narrow strip of copper or piece of heavy brass wire which serves the double purpose of a brace and handle. The strainer is made with a narrow flange at the top, in order that it may be held in place by a shoulder projecting from the edge of the opening in the tank. The opening is closed by means of a top, represented at Figs. 5 and 6. It is made of copper and is so simple in construction that further description is unnecessary. The two openings in the bottom of the tank are shown at *a* and *b* in Fig. 3. Into these is fitted the combined pump cylinder and air chamber, the ends *e* and *f* in Fig. 7 being the only parts that project outside the tank. By means of the two screw caps *a* and *b* in Fig. 3 the whole of this part of the machine is held firmly in place against the bottom of the reservoir, washers, of course, being used to prevent leakage.

Between the cap *a* and the tank there is fitted a small casting which serves to conduct the liquid from the air chamber into the hose shown at *c*, Fig. 3. The pump and air chamber are shown at Figs. 7 and 8, the plunger being removed from the cylinder merely to illustrate it more clearly. The air chamber *a* and the pump cylinder *b* are simply pieces of 2½ inch brass pipe 12½ and 4⅝ inches long respectively. Both are soldered to the casting C, a bottom view of which is shown at Fig. 9. The top of the air chamber is closed by means of a cap of heavy sheet copper *d*, soldered as firmly as possible to the brass pipe. The plunger

which works in the cylinder consists of a cone-shaped brass casting into which is fastened a similarly shaped piece of soft rubber, the base of the latter being a little larger than that of the former.

These various parts are all plainly shown at Fig. 8, *a* being the piston rod, *b* the cone-shaped brass receptacle for holding the piece of soft rubber shown at *c*. In Fig. 10 are shown the parts used in fastening the rubber to the brass cone, *a* being the end of the piston rod with screw thread, *b* tap, and *c* casting which fits between the tap and cone and holds the rubber in place. This casting is shown enlarged at Fig. 9. The manner of working the pump will be better understood by consulting Fig. 11 in which the flow of the liquid is represented by the arrows. When the piston is raised the liquid is drawn in at the opening *a*. The downstroke forces the liquid through the pipe *b* into the air chamber *c* and at the same time closes the ball valve *d*. Another upstroke is made and the ball valve *e* closes the opening at that point, thereby preventing the liquid from rushing back into the pump cylinder. This process being repeated the liquid remains under constant pressure in the air chamber and as a result it is forced through the hose, lance and nozzle shown in Fig. 1 in a constant spray. The lance and nozzle we use on this machine is the well known improved Vermorel. The other parts of the apparatus, such as the straps, handle, lever, etc., need no special mention, as any machinist will be able to see from the drawings how they are made and used. For the further benefit of any one desiring to manufacture the pump the dimensions of the various parts are given in detail at the close of the article.

As regards cost, the machine with two lances and nozzles sells in France for 40 francs, or about \$8. The duty, transportation, and other charges on the pump will bring the cost, laid down in this country, up to about \$20. This is for a single machine. Where a number are ordered at a time they can be delivered here for about \$15 each. Estimating labor at 40 cents an hour the machine complete, as we have described it, can be made in this country for about \$11.50.

If special appliances are used and the machines are turned out in large numbers, we see no reason why the actual cost of manufacturing could not be further reduced to \$10.50 or even to \$10 each. Manufacturing them at this price, it seems to us that they could be put on the market for \$12 or \$14 at a fair profit.

DIMENSIONS OF PARTS DESCRIBED ABOVE.

Reservoir, $17 \times 13\frac{1}{2} \times 4\frac{1}{2}$ inches.
Opening for liquid, $4\frac{1}{8} \times 7\frac{3}{8}$ inches.
Opening for piston rod, $\frac{5}{8}$ of an inch in diameter.
Opening for introduction of air chamber (*a* and *b*, Fig. 3), $\frac{3}{4}$ inch in diameter.
Strainer, $\frac{3}{8} \times 4\frac{1}{8} \times \frac{3}{4}$ inches.
Air chamber, $2\frac{1}{2} \times 12\frac{1}{2}$ inches.
Pump cylinder, $2\frac{1}{2} \times 4\frac{3}{8}$ inches.
Diameter of piston rod at top, $\frac{1}{2}$ inch.
Length of piston rod, $13\frac{1}{2}$ inches.
Diameter of cone-shaped casting (Fig. 9), $2\frac{1}{2}$ inches.
Height of cone-shaped casting, 2 inches.

NOTES ON SOME UREDINEÆ OF THE UNITED STATES.

By P. Dietel.

In a recent number of this journal Mr. Anderson has stated that *Uromyces sophoræ*, Pk., and *Uromyces hyalinus*, Pk., are identical, but erroneously says that they are referable to *Uromyces trifolii*, (Hedw.) Lév. In the latter fungus the same morphological characters are constant in both the American and European specimens, viz, dark brown teleutospores with a minute hyaline papilla; the latter often wanting. On *Sophora sericea* the spores are lighter in color and the papilla is very broad. There is still greater difference between the two species as regards their biological properties. Teleutospores only have been found on *Sophora*, and the fungus seems to hibernate by its mycelium. The affected plants, therefore, can be distinguished from the healthy ones by their slenderer growth. In the majority of specimens I have seen the sori appear on all the leaves of the plant, the youngest as well as the fully developed ones. *Uromyces hyalius* differs also from *Uromyces glycyrrhizæ*, (Rabh.) Magn., lately described by Prof. Dr. Magnus in the "Berichte der Deutschen Botanischen Gesellschaft." This fungus occurs in America on *Glycyrrhiza lepidota* and greatly resembles *Uromyces trifolii*, in its morphological characters, differing from it, however, by the perennial mycelium of the primary uredo stage and the absence of the æcidial fructifications.

In Hedwigia, 1889, p. 23, I have stated that *Uromyces caricis*, Pk., on *Carex stricta* is the Uredo of a Puccinia, which I have named *Puccinia caricis-strictæ*. As Prof. B. D. Halsted notes in the Journal of Mycology, vol. 5, p. 11, he has also seen the Puccinia, but considers it as a two-celled form of a normal Uromyces. But there can be no doubt that the so-called Uromyces is really the Uredo of the Puccinia, because it has four equatorial germ pores. *Uromyces perigynius*, Hals., is, however, a true Uromyces but the spores do not measure, as the author states, 4–6 by 8–10μ but 13–20 by 26–36μ.

Puccinia vernoniæ, Schw., is considered by most mycologists as a variety of *Puccinia tanaceti*, DC. or *P. helianthi*, Schw.; or as identical with *P. hieracii*, (Schum.) Mart. [*P. flosculosorum*, (Alb. & Schw.) Roehl]. A comparative examination of these species has shown that it is sufficiently different from any of them to constitute it a good autonymous species. It differs from *Puccinia hieracii* principally in having a much thicker epispore and frequently a thickening at the apex. In *P. helianthi* and *P. tanaceti* the teleutospores have a firm stalk and are clearly constricted at the septum, in *P. helianthi* more than in *P. tanaceti*. In the latter the spores, when examined dry, are beset with minute tubercules, in *P. helianthi* they are entirely smooth. The membrane of *P. helianthi* is thicker than that of *P. tanaceti*. *P. vernoniæ* has somewhat smaller spores than the two former species. They are usually not at all or only very little constricted at the septum, the membrane is beset

with tubercles and is even thicker than that of *P. helianthi*. The stalk is rather evanescent; its length differing on the different host plants. On *Vernonia fasciculata*, as has been stated by Professor Burrill, the length of the stalk is about four times that of the spore; on *Vernonia Baldwinii* it is much shorter, attaining only once or one and a half times the length of the spore. We might, therefore, distinguish two varieties of *P. vernoniæ* and designate the one on *Vernonia fasciculata* as var. *longipes*, the other on *Vernonia Baldwinii* as var. *brevipes*. I have not been able to examine this fungus on other host plants.

LEIPSIC, GERMANY.

NEW SPECIES OF UREDINEÆ.

By J. B. ELLIS and S. M. TRACY.

PUCCINIA HEMIZONIÆ, *n. s.* II, III.—Amphigenous; spots yellowish, rather large; sori small, scattered or sometimes confluent, surrounded by the remains of the ruptured epidermis; uredospores subglobose to oval, very slightly echinulate, thick walled, dark colored, 16–2 by 24–30μ; teleutospores obovate, occasionally three-celled, slightly constricted, apex much thickened, rounded or blunt pointed; epispore smooth, 22–24 by 45–48μ; lower segment lighter colored and tapering below to the flexuous, hyaline pedicel which is more than double the length of the spore. On *Hemizonia truncata*, Oregon.

ÆCIDIUM OLDENLANDIANUM, *n. s.*—Hypophyllous; æcidia few in a cluster, 80–100μ in length, the mouth but little split and not recurved; spores globose or sometimes slightly angled; epispore thin, smooth, bright yellow; 14–16μ. On *Houstonia cœrulea*, Starkville, Mississippi, April, 1888. Although the name "Oldenlandia" is obselete as applied to this host, the name given to this Æcidium on account of the name "houstoniatum" being already occupied by the *Æcidium houstoniatum*, Schw., from which this differs in the longer, narrower æcidia, smooth spores, and spermogonia rare or wanting.

ÆCIDIUM MALVASTRI, *n. s.*—Hypophyllous; spots light yellow; æcidia clustered, somewhat circinate, short, the spreading border rather narrow, spores subglobose or ovate, epispore thin, minutely tuberculate; 15–18 by 18–22μ; spermogonia unknown. On *Malvastrum Munroanum*, Albuquerque, New Mexico, Tracy, June, 1887.

NEWFIELD, NEW JERSEY.

A NEW PINE LEAF RUST.

(*Coleosporium pini*, n. s.)

By B. T. Galloway.

Early in May of the present year we found on the leaves of *Pinus inops*, near Washington, a *Coleosporium* which appears to be new, and which may be briefly characterized as follows:

Coleosporium pini, *n. s.*—III Amphigenous. Sori reddish orange, 1 to 5^{mm} long, or when confluent frequently attaining a length of 10^{mm} or more; spores irregularly clavate, smooth, 2 to 4 celled, 70–125 by 18–25μ. Forming yellow spots 4 to 25^{mm} or more long at or near the ends of *Pinus inops* leaves. The spores germinate readily in moist air by sending out one unseptate promycelium from each cell; upon the free ends of these tubes, which are of various lengths, the orange red sporidia are borne. Finding the *Coleosporium* nearly always associated with *Peridermium cerebrum*, Pk. led me to believe that it might be the teleutosporic form of this fungus. Cultures are being made to settle this and other questions connected with these interesting parasites, but as it will be at least a year before definite results can be obtained we have thought it best to briefly describe the *Coleosporium* here.

OBSERVATIONS ON NEW SPECIES OF FUNGI FROM NORTH AND SOUTH AMERICA.

By Prof. G. Lagerheim.

A NEW HOLLYHOCK RUST.

(Plate x.)

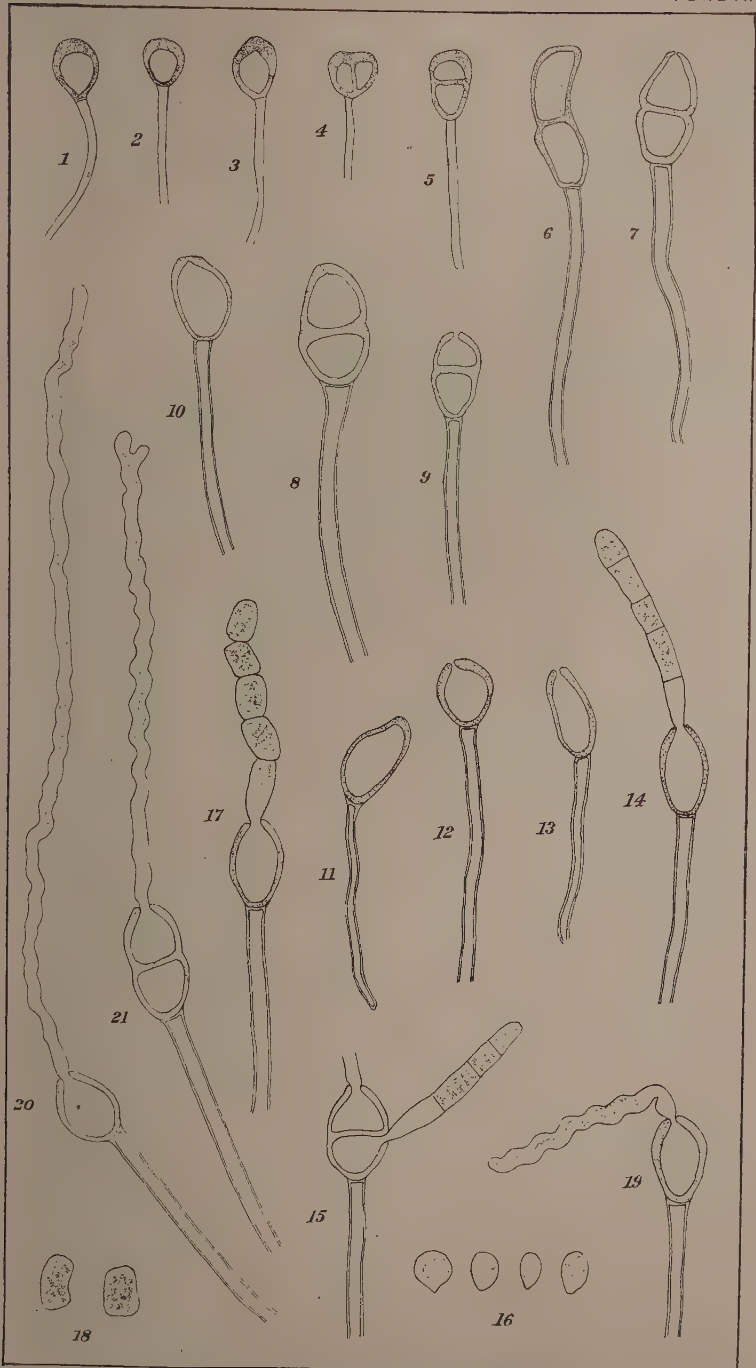
The Hollyhock (*Althæa rosea*) has several enemies among fungi. The most dangerous diseases of this ornamental plant are, as far as known, caused by *Puccinia malvacearum*, Montagne; *Cercospora althæina*, Sacc.* Recently Miss Southworth has directed attention to a new and dangerous disease of the Hollyhock caused by *Colletotrichum malvarum*,† (Br. & Casp.) South.

In the following lines I will describe a new Hollyhock disease caused by a fungus closely allied to and fully as dangerous as *Puccinia malvacearum*, Mont. As *P. malvacearum* has found its way from South America to Europe, it is not impossible that *P. heterogenea*, n. s., may also attack the Malvas of the Old World.

More than a year ago, while passing over the road between Guayaquil and Quito for the first time, I observed at several stations, viz, Chimbo, Guaranda, Mocha, etc., a rust on Malva which presented considerable

* B. D. Halsted, Garden and Forest, March 26, 1890.

† E. A. Southworth. A New Hollyhock Disease. Jour. Myc., vi, No. 2, p. 45, Plate III.



LAGERHEIM, ON A NEW HOLLYHOCK RUST.

microscopic likeness to *Puccinia malvacearum.* Since *P. malvacearum* originated in South America, I supposed I had found the fungus in its native place. Arriving at Quito, I found the same fungus everywhere on different species of Malva and on Hollyhocks, to which it was apparently very injurious. I soon learned from several gardeners that Hollyhocks did not thrive well in winter and often perished from a disease which manifested itself by large numbers of brown spots on the leaves and stems. I was also shown some of these diseased plants bearing the brown spots, in which I immediately recognized my *Puccinia* on *Malva.*

It struck me, however, that the sori were in general distinctly larger than those of *P. malvacearum*, which I have observed in several places in Europe, and therefore I made a microscopic examination. To my astonishment I saw at the first glance that the fungus was not *P. malvacearum*, Mont. at all, but an entirely different Puccinia. It more resembled *P. heterospora*, B. & C., and at first I thought I had this species before me, but on a closer comparison of the two fungi it soon became apparent that the fungus was also very clearly distinct from *P. hetero spora*, B. & C., and must be looked upon as a new species.

On account of a peculiarity of its spores, which will be alluded to directly, I have called the fungus *Puccinia heterogenea.*

The fungus is found during the entire year on *Malva nicæensis*, *M. crispa*, *M. Peruviana*, and *Althæa rosea*,* and is especially plentiful in winter (January to May), but it could never be found on several Sida species which grew in the immediate neighborhoood of the diseased Malvas. It occurs on all the green parts of the plant, especially on the leaves; on these it is almost exclusively on the under side, while on the upper side it causes roundish, strongly concave spots, which are reddish in the center and yellowish at the edges. The sori are about a millimetre in diameter and are crowded together, forming a large, strongly projecting, chestnut-brown cushion several millimetres in diameter; and on the thicker portions of the stems they are more than a centimetre long and a half centimetre broad. Around the spore masses and between the single sori are visible shreds of the ruptured epidermis of the leaf. The sori contain only teleutospores, which under proper conditions germinate immediately after ripening; the fungus, therefore, belongs to the class *Leptopuccinia.* The teleutospores occur in two forms, one-celled, which is the preponderating kind, and two-celled. The one-celled spores (Figs. 10–13) are roundish ovate, elliptical, or elongated, 30–45μ long, and 20–30μ broad; the two-celled spores (Figs. 6–9) are elliptical or ovate above, rounded or tapering below, and little or not at all constricted in the middle. The membrane of the spore is yellowish, little or not at all thickened at the apex of the spore and perfectly smooth. The germ pore of the upper half of the spore

* I have also seen the fungus in a botanical garden of this country very abundant on a Malva grown from European seed, but unfortunately not definitely determined.

lies at the apex and that of the lower half close to the dividing wall, as appears to be the case in nearly all Leptopuccinias. The pedicel is very long, three or four times as long as the spore, and nearly hyaline. The spore contents are reddish.

Among the species of Puccinia occurring upon the Malvaceæ (*P. sherardiana*, Kornicke; *P. lobata*, B. & C.; *P. abutili*, B. & Br.; *P. carbonacea*, Kalchbr. & Cke.; and *P. heterospora*, B. & C) only one, *P. heterospora*, B. & C., resembles *P. heterogenea*. Both species have this in common, that they have one-celled as well as two-celled teleutospores; but in other respects they are entirely different. In the two-celled spores of *P. heterospora* (Figs. 4, 5) the septum occupies very different positions, while in *P. heterogenea* it always has its normal position (Figs. 6–9). In *P. heterospora* the two celled spores occur very rarely, while in *P. heterogenea* they are very frequent. The differences come out very sharply when the two species are examined mingled together in the same preparation. Even macroscopically the two species can be easily distinguished from each other. In *P. heterospora* the single sori are smaller and darker colored and stand very many together. Finally there is a difference in the choice of host plants of the two species. *P. heterospora* attacks mainly species of *Sida* and *Abutilon*,* and not *Malva*. With *P. heterogenea* the opposite is the case. *Puccinia heterospora* appears to prefer a tropical or subtropical climate, while *P. heterogenea* has up to this time been found only in regions with a temperate climate. On this account it is not impossible that *P. heterogenea* may occur in North America or in Europe.

The germination of spores takes place very rapidly. Fresh masses which had been kept in a moist chamber produced promycelia and sporidia from almost all their spores in a few hours. The promycelium divides into from four to six cells, the lowest one of which soon loses its contents and is incapable of further development (Figs. 14, 15). The formation of sporidia takes place in the manner typical of the Leptopuccinias. In very moist air the promycelium often falls apart into single cells (Figs. 17, 18). The process of germination is quite different when the spores are in water. They then germinate exactly like uredospores; a long, non-septate germ tube, often bent backward and forward, and with a strongly undulating contour, (Figs. 19–21), grows out of the germ pore. Occasionally the commencement of branching has been observed at the end of the germ tube (Fig. 21). Probably the fungus can reproduce itself by these germ tubes, which, because they form no sporidia, penetrate directly into the leaf. But it is clear that this method of reproduction is of much less importance than reproduction by sporidia. At the most, each spore can produce two germ tubes, and these can only penetrate into the same leaf

* Compare Seymour, Distribution of *Puccinia heterospora* (Journal of Mycology, Vol. I, p. 94). In previous years in Jamaica I found the species on *Abutilon indicum* *A. periplocifolium*, and *Sida ciliaris*.

or one very close to it, because they are attached to the germ tube of the spore, and the spore itself does not become separated from its pedicel. If, on the contrary, the spore germinates in the air numerous sporidia are formed, which may be carried away by the air, etc., and will spread the fungus far and wide. In consequence of this it follows that it is of great advantage for the fungus that the sori should break out on the under side of the leaf. If they made their appearance on the upper side they would be wet by the rain and germinate by germ tubes. The different modes of germinating above described (which I have, moreover, noticed for other Leptopuccinias*) explains why nearly all Leptopuccinias form their sori mainly or exclusively on the under sides of the leaves. What the cause (light?) of this is remains to be ascertained.

A description of this species is given below: *Puccinia* (lepto) *heterogenea*, n. s. P. maculis epiphyllis rotundatis vel rotundato angulatis, medio purpureis lutescenti marginatis concavis; soris teleutosporarum hypophyllis vel caulicolis, pulvinatis, prominulis, congregatis, castaneis, mox nudis; teleutosporis continuis vel bicellularibus, ovoideis, oblongis, vel ellipsoideis apice et basis rotundatis vel parum attenuatis, membrana levi, luteola ad apicem paullulum vel non incrassata et pedicello hyailno teleutospora 3–4-plo longiore, persistente præditis. Long. teleutosp. 30–60μ; lat teleutosp. 20–30μ.

Hab. in foliis et caulibus vivis *Althææ rosæ*, *Malva crispæ*, *M. Peruvianæ*, *M. nicæensis* ad Quito, Mocha, Chimbo, Guaranda et aliis locis Æquatoriæ.

A NEW COTTON RUST IN ECUADOR.

Cotton, like other cultivated plants, is attacked by different kinds of fungi. Atkinson has recently described a new *Ramularia* on *Gossypium herbaceum* in Alabama. It is striking that up to this time no Uredineæ have been observed on the cotton plant, as the Malvas belonging to the same family are attacked by numerous species of rusts. This I think justifies the publication of a new Uredo on Gossypium, especially as the disease thus caused is very injurious, and the cotton one of our most important cultivated plants. I discovered the fungus in the following manner: On December 10 of the preceding year I took a trip from Quito to Guayaquil to study the fungi and algæ of the tropical region. By December 15 I had arrived at Balsapamba (Province of Los Rios), in the tropical region on the Rio Crystal, where I stopped for a day. The owner of the "casa ponada," Senor Vasquez, took me around his plantation of coffee, oranges, and pineapples, and in the pineapple garden I noticed the diseased cotton plants. Senor Vasquez had planted here some of the shrub-like Gossypium, ordinarily planted in the equatorial coast region, and which yields large crops of good

* The same thing appears in Gymnosporangium. Compare Kienitz-Gerloff in Botanische Zeitung, 1888, p. 389, and Richards in Bot. Gazette, 1889, No. 9.

cotton. But he complained that his plants were diseased and only yielded a little cotton. In fact, the bushes with their dead and fallen leaves presented a very sorry appearance, and even the leaves that were still green were apparently attacked by a disease which showed itself in the form of very numerous small spots. I took a few leaves with me, believing it was a Sphæriacea or Sphæropsidea which had attacked the green parts of the plant. A few days later, when I arrived in Guayaquil, I examined the fungus microscopically, and was very much surprised when I found it to be a Uredo. On my return to Quito I stopped at Balsapamba to collect more of the fungus, but the disease had advanced so far that nearly all the leaves had fallen off and were destroyed. The rainy weather at the end of December and the beginning of January had apparently favored the growth of the fungus very much.

I will pass now to a more exact description of the fungus. As has been said, it affects all green parts of the plants. On the upper side of the leaves it produces small, purplish brown, roundish, or angular spots, either scattered or confluent in larger spots. The attacked leaves dry up and become brown. The sori are at first covered by the epidermis, and afterward break through on both sides of the leaf, especially on the under side. In structure the sori correspond perfectly to the Uredo of a Puccinia. The spores are not surrounded by a pseudo peridium, and are formed singly on pedicels. They are oval, ovate, or pear-shaped, with a thin, uniform, shiny, light yellow membrane and colorless contents. Their length is 24–30μ and their breadth 15–18μ; club-shaped paraphyses are present. The spores germinate in the ordinary manner. Whether this disease is limited to Ecuador or distributed elsewhere I can not now state. Cotton is now cultivated to a less extent than formerly on the coast and perhaps *Uredo gossypii* is the cause. Dr. Rimbach writes me from Cuenca that a cotton disease is known there under the name "Cancha." The name is also given to the diseases of potato, rice, coffee, bananas, etc., so that without the diseased cotton plants for examination it is impossible to say what it represents. Description as follows:

Uredo gossypii, *n. s.*—U. amphigeni. Maculis parvis purpureobrunneis, sparsis vel confluentibus; soris præcertim hypophyllis, flavescentibus; sporis ovoideis, ovalibus, vel pyriformibus; 24–30μ longis, 15–18μ latis, membrana æquali, pallide flavescenti, echinulata, contentu achroo; paraphysibus claviformibus immixtis.

Hab. ad Balsapamba, Prov. de los Rios Æquatoriæ in foliis *Gossypii* sp., parasitica (Dec., 1890).

A NEW DOASSANSIA ON COTTON.

In a search to discover the teleutosporic form of *Uredo gossypii* I unexpectedly found a *Doassansia* on the cotton leaves. As the fruiting bodies of this fungus are not visible to the naked eye, they escaped me

before. So far as I am aware no Ustilagineæ have been observed on Malvaceæ, and on this account I think a short description of *Doassansia gossypii* will not be without interest.

The fruiting bodies form minute black points in the leaf substance. They appear to originate in the same way as Fisch* has described for D. *sagittariæ*, (West) Fisch. The ripe spores are oval, elongated, or pointed, 21–30μ long, 12–15μ broad, often somewhat angular and are firmly bound together. Their membrane is somewhat thick and of a slightly yellowish color, often rather strongly thickened at the corners of the spore. The outer cells are somewhat smaller than the spores, without contents, and with a brown membrane. This species has larger spores than any species of Doassansia known up to this time. Below is a description of the fungus:

DOASSANSIA GOSSYPII, *n. s.*—D. soris rotundatis punctiformibus, minimis, sparsis, atris sporis arcte conjunctis, ovalibus vel oblongis, 21–30μ longis, 12-15μ latis, episporio levi, dilute luteolo, tegumento communi e cellulis minoribus, membrana fusca, levi constituto.

Hab. in foliis Gossypii, spec. ad Balsapamba. Prov. de los Rios, Æquatoriæ.

A NEW PERONOSPORA ON GONOLOBUS FROM SOUTH CAROLINA.

While examining a *Leptopuccinia* collected on an Asclepiad at Quito, and comparing it with *Puccinia gonolobi*, Rav., I found a new Peronospora in considerable quantity on the specimens bearing this fungus (S. C. Mellichamp, Herb. Farlow).

The fungus forms large angular spots bounded by the nerves on the lower surface of the leaves. On the upper side they appear yellowish. The conidiophores are very slightly swollen at the base, several times dichotomously branched, with straight branches pointing obliquely upward. The lower part is 8.5–11μ in diameter. Its membrane is thin and colorless. The end branches are straight and conical, 6–9μ long. The conidia are roundish, ovate, with a pointed end and light violet gray membrane; their length measures 18–24μ and their breadth 16–21μ. I have not found oospores. The characteristics of the species are as follows:

PERONOSPORA GONOLOBI, *n. s.*—P. conidiophoris arborum modo repetite dichotomis ramulis rectis, membrana achroa, ad basim parum inflatis 8.5–11μ latis; ramulis terminalibus rectis 6–9μ longis; conidiis globoso-ovatis membrana pallide griseola 18–24μ longis, 16–21 latis; oosporis ignotis.

Hab. in foliis *Gonolobi* in South Carolina, U. S. parasitica.

QUITO, ECUADOR.

* C. Fisch, Entwickelungsgeschichte von *Doassansia sagittariæ* (Ber. d. Deutsch. Botan. Ges. Bd. II, 1884.)

DESCRIPTION OF PLATE X.

Figs. 1- 5. *Puccinia heterospora*, B. and C. The spore contents are not drawn with the same magnifying power.

6-21. *Puccinia heterogenea*, n. s.

1- 3. One-celled spores.

4- 5. Two-celled spores.

6- 9. Two-celled spores, of which 7 and 9 have germinated.

10-13. One-celled spores, of which 12 and 13 have germinated.

14. A one-celled spore which has germinated, and the promycelium divided into five cells.

15. A two-celled germinated spore; the promycelium has divided into four cells.

16. Sporidia.

17. A germinated spore whose promycelium has fallen apart into single cells.

18. Isolated cells of the promycelium.

19-21. Spores which have germinated in water and formed a long germ tube. In Fig. 21 the germ tube is branched at the end.

REVIEWS OF RECENT LITERATURE.

BREFELD, OSCAR.—*Untersuchungen aus dem Gesammtgebiete der Mykologie. Heft IX.* Munster i. W. 1891, pp. VIII, 156, pl. 4.

This indefatigable German botanist has recently given to the press the ninth part of the above work, and by this time no doubt has the tenth part before the public. These two parts represent 10 years of investigation, the last four of which have been entirely devoted to this work. Owing to the loss of one eye he has been obliged to have the constant help of an assistant, whose aid he acknowledges both in the prospectus and on the title page. The assistants in the work were Dr. Franz von Tavel and Dr. Gustav Lindau.

Dr. Brefeld feels that with the issue of these two parts and the plans of three more in hand, he can at least fully claim that he has laid the foundation for a natural system in the classification of fungi—a system which hitherto has made itself painfully conspicuous by its absence, and which can not be too warmly welcomed, or too thoroughly studied by American mycologists.

Part IX consists of five divisions. The first division is explanatory of the rest. The second takes up spermatia and their culture in nutrient solutions, shows that they are capable of germination and independent development and hence are a form of asexual reproduction distinguished from other spore forms only by their size.

Division 3 deals with the asci of Ascomycetes in their relation to basidia and simpler fruit forms. In this the author traces the relationship between conidia and sporangia and attempts to establish that the former is only a variation of the latter. Starting with these two he traces the

development of sporangia to asci, and of the conidia through the simpler basidia forms to the more complex forms involved in the Basidiomycetes. The transition forms between the Phycomycetes on the one side and the Ascomycetes and Basidiomycetes on the other he uses to form a new class, the Mesomycetes, and divides it into the two parts Hemiasci and Hemibasidii. The fourth division is devoted to the former of these and treats *Ascoidea rubescens*, *Protomyces pachydermus*, and *Thelobolus stercoreus* in detail.

The Ascomycetes are further divided into the Exoasci and Carpoasci, and the fifth division takes up four species of the former. The Carpoasci are treated in part X.

The prospectus for these two parts also announces the subject matter for three more, one of which, the eleventh, is now nearly completed and will form a continuation of part V on the Ustilagineæ, which Brefeld ranks with the Hemibasidii.

Part XII will give his culture methods in detail, and XIII will begin the supplement to his earlier researches on the higher fungi.—E. A. SOUTHWORTH.

COMES, Dr. O. *Crittogamia Agraria.* Naples, 1891. Pp. 600, pl. XVII.

This work, which has just been issued by Dr. Comes, will be of great value to American workers, especially as it brings together in convenient form the latest information on the plant diseases of a number of countries where the literature is scattered and hard to obtain. The first 15 pages of the book are devoted to a discussion of the effects of soil, air, temperature, etc., on vegetation. This is done, so the author states, to render what is said upon parasitic fungi more readily understood. After discussing the nature of parasitic fungi, polymorphism, germination of spores, classification, etc., the diseases of plants caused by the Peronosporeæ are taken up. Under this head a number of well known parasites, such as *Phytophthora infestans*, *Peronospora parasitica*, *Plasmopara viticola*, etc., are discussed. Following this are nearly 400 pages of observations on a long list of fungous diseases.

Chapter XXX, which opens on the 493d page, deals with the bacterial diseases of plants. Beginning with pear blight, the author discusses a bacterial disease of corn, mulberry, sorghum, potato, onion, hyacinth, pelargonium, pine, olive, and grape (stem). The tubercles found on legumes also receive considerable attention in this chapter. The volume concludes with a chapter on Myxomycetes and a good index.—B. T. GALLOWAY.

MORGENTHALER, J. *Der Falsche Mehltau, sein Wesen und seine Bekämpfung.* Zürich, 1891. Pp. 73, figs. 5.

German viticulturists have not as yet been obliged to combat the black rot fungus; but since 1880, when the downy mildew was first found in Switzerland, this latter fungus has gradually forced itself upon their

attention, and within the last few years some systematic attempts at treatment have been carried on.

The results of these experiments, as well as descriptions of the fungus, its history, and the history of the use of fungicides in Switzerland, together with modes of treatment and descriptions of spraying pumps, have been combined into a pamphlet of seventy-three pages, which will serve as an excellent handbook for the treatment of downy mildew. In this country, where mildew is one of the minor troubles of the grape-grower, and is always held in check by treatments for black rot, such a work would be of comparatively little use; but in a country where the question of conquering mildew is of paramount importance, it will be of great value to practical vineyardists. The descriptions of the fungus and methods of treatment are especially adapted to those who look at the subject from a practical standpoint. A noticeable defect in the book is the absence of accurate data. The reader is simply told that one fungicide gave better results than another, or that much or little was saved by its use. A few data as to the weight of the fruit and condition of the vines would add much to the value of these statements. Two fungicides are recommended as best adapted for preventing mildew—Bordeaux mixture and another mixture in which soda is used instead of lime. Accurate estimates as to the cost of the fungicides, and directions for their preparation are given. Some important questions in regard to the latter point were referred to a German chemist, and a few points in his report are worthy of special mention. He advises that the mixtures should always be prepared cold, and that in order to obtain the precipitate in the most finely powdered condition, the more concentrated solution should be poured into the dilute one. He further advises that the copper solution be the concentrated one in both mixtures.—E. A. SOUTHWORTH.

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

By DAVID G. FAIRCHILD.

243. ANDERSON, F. W. **A new Fomes from northern Montana** (with plate XII). Bot. Gaz., April 18, 1891, p. 113. Describes *Fomes Ellisianus* on *Shepherdia argentea.*

244. ARMSTRONG, L. H. **Smut and rust fungus.** Florida Dispatch, Farmer and Fruit-Grower, Jacksonville, Fla., May 28, 1891, No. 1165, vol. III, No. 22, p. 429 (2 columns). Gives extracts with comments from bulletins of Kansas Ex. Station in regard to prevention of smut in cereals. (See Nos. 156, 157, 212.)

245. ARTHUR, J. C. **Loose smut of oats.** Bull. 35, vol. II, March 30, 1891, Purdue University, Lafayette, Ind. Ag. Ex. Sta., pp. 81–107. Discusses abundance of disease, recording on the station farm a loss of 18 per cent and estimating the loss in Indiana in 1889 as equaling $797,526 and in 1890 $605,352. Describes the hot-water treatment, giving an experiment with 12 lots of seed dipped in hot water of 7 different degrees of temperature from 120° F. to 150° F., which resulted in a decrease of the amount of smut in every case. The tem-

245. ARTHUR, J. C.—Continued.

perature of the water selected as most advisable in practical treatments is 135° F., with time of immersion of 5 minutes. Shows further that the average height of treated seed when full grown is greater than that of untreated, and records experiments upon effect on vitality of seed treated with hot water, showing that the treatment up to a certain point hastens germination in a very remarkable degree, and also that no injury is sustained by treated seed when treated as long as 277 days before planting. Experiments with copper sulphate show this substance to retard germination and decrease the yield, although preventing the smut.

246. ATKINSON, GEORGE F. **Black rust of cotton.** A preliminary note; Bot. Gaz., vol. XVI, No. 3, pp. 61–65.

246*a*. ———. **Black Rust of Cotton**, Bull. 27, Agrl. Ex. Sta., Auburn, Ala., May, 1891, pp. 1–16. Attributes disease to attacks of four parasites, *Colletotrichum gossypii*, South., *Macrosporium nigricantium*, Atkinson (with figs.), *Cercospora gossypina*, Cooke, a species of *Alternaria* and a bacterial organism. Gives history and description of the different forms, with notes upon the current theories as to the cause of the rust; the parts most subject to diseases, power of the plant to resist fungous parasites, and prospective outline of experiments.

247. ———. **Some Erysipheæ from Carolina and Alabama** (with plate and figs.). Journal Elisha Mitchell Scientific Society, 1890, 7th year, part II (published 1891), pp. 61–74. Offers results of the study of material collected in North and South Carolina and Alabama as a contribution to the knowledge of the Southern forms. Puts the matter in convenient shape for collectors and students, describing genera and species with hosts plants, as follows: *Sphærotheca castagnei*, Lev.; *S. humuli*, (DC.) Bur.; *Erysiphe communis*, (Wallr.) Fr.; *E. cichoracearum*, DC.; *E. liriodendri*, Schw.; *Uncinula spiralis*, B. & C.; *U. macrospora*, Peck; *U. flexuosa*, Peck; *U. parvula*, C. & P.; *U. polychæta*, (B. & C.) Masse; *Phyllactinia suffulta*, (Rab.) Sacc.; *Podosphæra biuncinata*, C. & P.; *Microsphæra semitosta*, B. & C.; *M. diffusa*, C. & P.; *M. vaccinii*, C. & P.; *M. euphorbiæ*, B. & C.; *M. Van Bruntiana*, Ger., which the author, in contradistinction to Burrill, separates from *M. alni*, (DC.) Winter, on account of the difference in appendages (with figs.), *Microsphæra quercina*, (Schw.) Burrill; *M. calocladophora*, Atkinson (*M. densissima*, E. & M. Jour. Mycology, vol. I, 1885, p. 101.)

248. BESSEY, C. E. **An important work on the fungi.** American Naturalist, February, 1881, vol. XXV, No. 290, p. 150. Mentions Ellis & Everhart's new work on Pyrenomycetes. (See No. 193.)

249. BJERGAARD, J. PEDERSEN. **Prevention of rust in cereals.** American Agriculturist, March, 1891, vol. L, No. 3, p. 136. Discusses various methods of treatment with hot water for the prevention of *Puccinia graminis*. Describes it to be prevented by immersing the seed grain for a certain time in warm water of a certain temperature, followed by rapid cooling in cold water. Gives the following instructions: For prevention of rust in barley: "Immerse the seed barley perfectly in cold water for 4 hours; let it stand in wet bags in a cool, not too drying place for at least 4 hours more before the dipping in warm water is to be performed." Finds 123° F. to be sufficiently high temperature for the water to immerse seed grain in. Describes method of dipping as in case of smut of cereals. Concludes for oats, wheat, and rye, the grain may be dipped without previous soaking and that the temperature of the water for oats and wheat must be 133° F., to begin with, and 129° F. at end. Reports temperature of 126° as proving preventive of the rust. Discusses forms of hampers for containing seed. Refers to work of Jensen.

250. BOLLEY, H. L. **Grain smuts** (with figs.). Bull. No. 1, Agrl. Ex. Station, Fargo, N. Dak., June, 1891. Brings together work of Arthur, Kellerman and Swingle, Jensen, and others upon the subject, using figures from various authors, together with original. Adds much of popular nature to express results obtained by various investigators.

251. BUTZ, GEORGE C. **Black knot on plums** (with plates). Bull. 13, Penn. State Ag. Ex. Sta., October, 1890, p. 34. Instructs orchardists how to eradicate disease by usual methods of pruning.

252. CLARK, JOHN W. **Spraying for codling moth and apple scab** [*Fusicladium dendriticum*, (Wall.) Fckl.]. Bull. 13, Miss. Ag. Ex. Sta., January, 1891, p. 6. Reports good results from use of Bordeaux mixture in treatment of disease.

253. ———. **Black rot of the grape** [*Læstadia Bidwellii* (Ell.) V. & R.] *Ibid.* Gives inconspicuous results from use of Bordeaux mixture in treatment of the disease.

254. ———. **Experiments with the Bordeaux mixture upon the grape rot** [*Læstadia Bidwellii*, (Ell.) V. & R.]. Bull. 10, Ag. Ex. Sta., Columbia, Mo., April, 1890, p. 5. Reports saving of 75 per cent of grape crop by spraying with Bordeaux mixture after rot had appeared.

255. COOKE, M. C. **Additions to Merulius.** Grevillea, June, 1891, vol. XIX No. 92, p. 108. Describes *Merulius rimosus*, Berk., in Herb. on Alder from New York, collected by J. B. Ellis, No. 586.

256. DIETEL, P. **Bemerkungen über die auf Saxifragaceen vorkommenden Pucciniaarten.** Berichte der Deutschen Botanischen Gesellschaft IX. März 23, 1891, pp. 35–45, Taf. III. Gives comparison of species of Puccinia on the *Saxifragaceæ*, with numerous references to the North American species, which he decides referable to *P. saxifragæ*, Schlect. (*P. curtipes*, Howe); *P. adoxæ*, DC. (*P. pallido-maculata*, E. & E.); *P. heucheræ*, (Schw.). Thinks *P. striata*, Cke., No. 1465 N. A. F., incorrectly determined, while *P. spreta*, Pk. and *P. tiarellæ*, Pk. are probably identical with *P. heucheræ*, (Schw.) and only slightly different from *P. congregata*, Ell. & Hark.

257. ELLIS, J. B., AND ANDERSON, F. W. **New species of Montana fungi** (with figs. and plate). Bot. Gaz., vol. XVI, No. 2, February 15, 1891, pp. 45–49. Describe *Lentinus pholiotoides*, *Helotium Montaniense*, *Volutella occidentalis*, *Sporidesmium sorisporioides*, *Macrosporium puccinioides*, *Æcidium liatridis*, *Æcidum cleomis*, *Æcidium chrysopsidis*, *Pestalozziella Andersoni* Ell. & Everh., as occurring in Montana; and (out of place according to title), *Phoma ilicina* and *Coniothyrium ilicinum* upon *Ilex*, and *Dothiorella nelumbii* on receptacle of *Nelumbium;* from Washington, D. C.

258. ——— AND EVERHART, B. M. **Note sur un Coprir sclératoide observé à Montana** (with plate). Revue Mycologique, 13 a'n. Jan. 1891, No. 49, pp. 18–20. Traduit par M. O. Debeaux du texte Anglaise. Describes *Coprinus sclerotigenus*, n. s. from Montana arising from a sclerotium, although resembling somewhat *C. tuberosus*, Quelet, found in France (see No. 38).

259. FAIRCHILD, D. G. **A few common orchard diseases.** Fancier and Farm Herald, Denver, Colo. Gives popular exposition of more common diseases, with well-known remedies for treatment of same.

260. ———. **Diseases of the grape in western New York.** Paper read before the annual meeting of the Western New York Horticultural Society, Rochester, January 28–29, 1891. Proc. 36th Ann. Meeting of Western New York Hort. Soc., p. 76. Same in Garden and Forest, vol. IV, No. 154, February 4, 1891, p. 59. Cultivator and Country Gentleman, Feb. 26, 1891, vol. LVI, No. 1987, p. 169. The Vineyardist, Penn Yan, N. Y., April 1 and 15, 1891, vol. III, Nos. 71 and 72, pp. 490, 497. Vick's Illustrated Monthly Magazine, Rochester, N. Y., vol. 14, No. 3, March, 1891, pp. 98–112. Discusses in a more or less popular way the diseases caused by *Peronospora viticola*, (B. & C.) DBy.; *Uncinula spiralis*, B. & C.; *Læstadia Bidwellii*, (Ell.) V. & R.; *Glæosporium fructigenum*, Berk.; and *Sphaceloma ampelinum*, DBy. Gives method of treatment of various diseases, and a note upon a new disease in the region similar to the French malady of *Rougeot.*

261. FLETCHER, JAMES. **Black knot of the grape.** Appendix to Report of Minister of Canadian Agricultural Experimental Farm, Ontario, Canada for 1889 (1890):

261. FLETCHER, JAMES—Continued.
Report of Entomologist, p. 87. Notes occurrence near Port Hope, Ontario, of a peculiar cracking of the bark of the grape canes, known among Germans as "Krebs" or "Schorf," and attributed to freezing of the canes.

262. GALLOWAY, B. T. **Report of the Chief of the Division of Vegetable Pathology, in Ann. Report for 1890, U. S. Dept. of Agriculture** (issued 1891). Treatment of black rot of the grape (see No. 196): Gives results of experiments in Virginia, as described in Journal, vol. VI, No. 3, pp. 89–95. Treatment of pear, cherry, and strawberry leaf-blight as affecting nursery stock: Reports successful prevention of pear leaf-blight by applications of Bordeaux mixture. Finds cherry leaf-blight prevented by either ammoniacal solution of copper carbonate or Bordeaux mixture. Reports successful use of ammoniacal solution in preventing strawberry leaf-blight, giving figures of cost of treatment. Treatment of pear leaf-blight and scab in the orchard: Gives results of comparative test of Bordeaux mixture, ammoniacal solution of copper carbonate, copper acetate (verdigris), and copper carbonate in suspension, with expense of various treatments. Places fungicides as above in order of effectiveness, and finds three early sprayings equally as effective as six continued through the season. Experiments in the treatment of apple scab: Concludes that scab can not be wholly prevented in an unfavorable season by use of ammoniacal solution, Bean's sulphur powder, Mixture No. 5 (equal parts of ammoniated copper sulphate and carbonate of soda), or copper carbonate suspended in water. Finds Mixture No. 5 most effective; early treatment before the opening of the flowers extremely important, and midsummer sprayings of doubtful value. Raspberry leaf-blight: Discloses the fact that raspberry foliage is too delicate to withstand action of Bordeaux mixture or Mixture No. 5; that blackberry foliage, while more resistant than raspberry, is more susceptible than apple. Experiments in the treatment of potato rot: Reports increase in yield of treated over untreated of 25 to 50 per cent. Some practical results of the treatment of plant diseases: Gives figures of expense of treatments made by practical growers. Fungicides and spraying apparatus: Discusses various new fungicides and apparatus. Peach yellows investigation: Gives brief summary of work of Dr. E. F. Smith upon the subject. The California vine disease: Reviews in brief the work of N. B. Pierce, both in the United States and Europe, upon this disease, announcing no definite results. Hollyhock anthracnose [*Colletotrichum malvarum*, (A. Br., & Casp.) Southworth], with colored plate: Gives short statement of the disease affecting greenhouse hollyhocks. Anthracnose of cotton (*Colletotrichum gossypii*, South), with colored plate: Gives brief account of the disease. Ripe rot of grapes and apples (*Glœosporium fructigenum*, Berk.), with colored plate: Short account of the disease described at length in the Journal, vol. VI, No. 4, pp. 164–173.

263. GOFF, E. S. **Bordeaux mixture as a preventive of potato rot.** Rural New Yorker, June 13, 1891, vol. L, No. 2159, p. 453. Gives abstract of report to be published by the Division of Vegetable Pathology upon successful use of Bordeaux as preventive of potato blight. The disease is thought to be different from that caused by *Phytophthora infestans*, DBy, and to resemble the bacterial disease mentioned by Burrill (see No. 188).

264. HALSTED, B. D. **Black rot of the sweet potato** (with fig.). Pop. Gardening, April, 1890, vol. 6, No. 7, p. 128. Gives popular description of *Ceratocystis fimbriata*, Ell. & Hals.

265. ———. **The hydrangea blight.** Garden and Forest, New York, vol. IV, No. 164, April 15, 1891, p. 177 (½ column). Notes serious abundance of *Phyllosticta hydrangeæ*, E. & E., in New Jersey. Recommends ammoniacal solution of copper carbonate as preventive.

266. HALSTED, B. D. **Mildew of sweet alyssum and radish.** *Ibid.*, vol. IV, No. 165, April 22, 1891, p. 189 (½ column). Notices presence of *Peronospora parasitica* on sweet alyssum spread from radishes in greenhouse.

267. ———. **Decay spots upon leaves.** Garden and Forest, vol. IV, No. 166, p. 201, April 29, 1891. Remarks *Botrytis vulgaris* previously nourished on blossoms as cause of decayed patches upon many greenhouse plants.

268. ———. **An abundant rust.** *Ibid.*, No. 171, vol. IV, June. 3, 1891, p. 262. Notices abundance of *Cæoma nitens*, Schw. in 1891.

269. ———. **The forest in one of its relations to the orchard.** Forest Leaves, Philadelphia, March, 1891, vol. III, No. 5, pp. 68–70. Notes presence of black knot (*Plowrightia morbosa*) upon various wild species of *Prunus* and of *Gymnosporangium* upon wild *Juniperus*, recommending the destruction of wild species to protect the orchard trees.

270. ———. **Destroy the black knot of plum and cherry trees** (with figs.). An appeal. Bull., 78 Ag. Ex. Sta., New Brunswick, N. J., pp. 1–14. Describes disease popularly, with instruction of how it may be prevented and an appeal for coöperation in its eradication.

271. ———. **Smut fungi** (with figs. from No. 53). Cultivator and Country Gentleman, Albany, N. Y., June 18, 1891, vol. LVI, No. 2003, p. 491 (2 columns). Gives popular account of different forms of wheat, oat, and corn smut, and conclusions reached by Brefeld delivered in lecture before Agricultural Society of Berlin and translated in Journal of Mycology for 1890. Brings out the main conclusions of the author in a popular way.

272. ———. **The black knot of plum and cherry trees** (with figs.). American Agriculturist, vol. L, No. 5, May, 1891, p. 281. Gives popular description of disease with recommendation to cut out and destroy all infected portions.

273. ———. **The soft rot of the sweet potato** (with figs.). American Agriculturist, March 1891, vol. L, No. 3, p. 146 (2 columns). Gives popular account of trouble caused by *Rhizopus nigricans*, Ehr., with recommendation for careful handling and digging to avoid spread of the fungus. Recommends storing in warm room until all "sweating" is over.

274. ———. **The theory of fungicidal action.** American Agriculturist, New York, June 1891, vol. L, No. 6, p. 323 (1 column). Discusses philosophy of fungicides in popular language. Claims action to be twofold, first by killing fungous spores at forming, and second by killing them as they germinate upon the leaf.

275. HUMPHREY, J. E. **Notes on technique. II.** Bot. Gaz. vol. XVI, No. 3, March 16, 1891, pp. 71–73. Gives account of successful use of 1 per cent solution of osmic acid in killing zoöspores preparatory to staining with alcoholic solution of Hanstein's rosanilin-violet. Finds cilia even in zoöspores of *Achyla polyandra* readily stained by the method.

276. ———. **The black knot of the plum** [*Plowrightia morbosa*, (Schw.) Sacc.] (with plate). Eighth Ann. Rep. of Mass. State Ag. Ex. Station, Amherst, Mass., 1890. Issued January 9, 1891. Gives report on laboratory investigations now in progress, with carefully prepared history of the disease. Reports the malady as strictly American and first described as of fungous origin by de Schweinitz in 1831. Finds the disease distributed throughout the United States, but rare in Texas. From sowing of ascospores in agar the author has succeeded in bringing to maturity the true pycnidial form which had not previously been described. So far as the investigations have gone the author is able to connect positively only three forms, with the black knot the ascospores, the pycnidial form, differing from the pycnidial stage described by Dr. Farlow, and the summer or conidial stage. Decides the stylosporus form described by Farlow as not connected with *Plowrightia morbosa*, and fails to find the presence of the spermogonial stage of this author, but

276. HUMPHREY, J. E.—Continued.
observes in a few cases small spore fruits which may be identical with Dr. Farlow's pycnidia.

277. ———. **The cucumber mildew** [*Plasmopara Cubensis*, (B. & C.)], (with plate). *Ibid.*, pp. 210–212. With history of disease. Gives account of distribution and comparison with the only other known *Peronospora* upon *Cucurbitaceæ* in the United States, *Plasmopara Australis*, (Speg) Swing. Decides both species upon the wild star cucumber (*Sicyos*) and cultivated cucumber are *Plasmoparæ*.

278. ———. **The brown rot of stone fruits.** (*Monilia fructigena*, Pers.) *Ibid.*, pp. 213–216. Reports upon laboratory investigations with the fungus, showing that mummified specimens of plums are able to carry over winter the power of reproducing abundant conidia. From cultures in agar concludes *Monilia fructigena*, Pers., as probably an autonomous fungus and likely to be readily eradicated from orchards by clean culture. Recommends concerted action in removal of infected fruits.

279. ———. **Potato scab.** *Ibid.*, pp. 216–220. Discusses work of other investigators upon the disease, expressing the opinion that the "deep" and "surface" scab are probably not specifically distinct. Thinks the invariable connection of the scab with a parasitic fungus has not been proved. Finds the conditions which least favor the appearance of the disease afforded by *light, open, thoroughly drained soil.*

280. ———. **Damping off** (with figs.). *Ibid.*, pp. 220–221. Identifies cause of disease with presence of *Pythium de Baryanum*, Hesse, and recommends prompt burning of affected plants and removal of infested soil.

281. ———. **The mildew of spinach** [*Peronospora effusa*, (Grev.) Rabh.]. *Ibid.* Notes disastrous presence of fungus in Massachusetts on an allied plant, *Chenopodium album.*

282. ———. **The grape-vine mildew** [*Plasmopara viticola* (B. & C.), Berl. & de Toni]. *Ibid.*, p. 222. Notes occurrence of the species upon *Ampelopsis veitchii* last October at Amherst, Mass.

283. ———. **Potato rot** [*Phytophthora infestans*, (Mont.) DBy.]. *Ibid.*, p. 223. Notes abundance in Massachusetts.

284. ———. **The elder rust.** (*Æcidium sambuci*, Schw.). *Ibid.*, p. 223. Notes destructive abundance on cultivated varieties of *Sambucus*.

285. ———. **The rust of blackberries and raspberries** (*Cæoma nitens*, Schw.). Describes the disease popularly.

286. ———. **The hollyhock rust** (*Puccinia malvacearum*, Mont.). *Ibid.*, pp. 224–225. Gives history of the spread of the disease introduced first from Chili.

287. ———. **Disease of oats.** *Ibid.*, p. 225. Notes occurrence in Massachusetts of a disease of oats not caused by *Uredineæ*, and connected more or less closely with bacteria. Refers to work of Division of Vegetable Pathology upon a similar disease (see THIS JOURNAL, vol. VI, No. 2, p. 72).

288. KELLERMAN, W. A. **Note on the distribution and ravages of the hackberry branch knot** (with plates). Twenty-third Ann. Meeting Kansas Academy of Science, Vol. XII, 1890 (1891), pp. 101–104. Gives counties of State from which the disease has been reported. Thinks it extends west to the limit of forest vegetation (see No. 62).

289. ———. **Jensen's recent experiments.** The Industrialist, Manhattan, Kans., vol. XVI, No. 35, May 23, 1891 (2 columns). Quotes at length from a letter by J. L. Jensen, of Denmark, giving results of treatment in 1890 of seed wheat and oats for smut. Jensen finds the hot-water method and Kuhn's method the only fully satisfactory ones. Quotes Jensen as concluding for four varieties treated that "there was gained by the hot-water method 1 per cent in replacing smutted heads with sound ones, but $8\frac{2}{3}$ per cent as an extra benefit; perhaps mainly due to the prevention of "invisible smut." Notes

289. KELLERMAN, W. A.—Continued.
difference in treatment between Jensen and Kellerman & Swingle, consisting in difference in time of immersion in hot water.

290. ——— AND SWINGLE, W. T. **Notes on sorghum smut** (with plate). Report 23d Ann. Meeting Kansas Academy of Science, vol. XII, 1890, extract (1891), p. 158. Give brief account of *Ustilago sorghi*, (Link?) Passerini and *Ustilago Reiliana*, Kühn, which latter is reported for the first time in the United States.

291. ———. **Additional experiments and observations on oat smut, made in 1890.** Bull. No. 15, Dec., 1890, Agr'l Ex. Sta., Manhattan, Kans. (Issued March 20, 1891.) Continue work of previous year upon the subject, giving results of extended experiments in the prevention of the disease, including the test of 155 treatments of seed previous to planting. Give numerous observations as to the amount of smut, concluding from a careful estimate that there was in the State of Kansas a loss in 1890 of between 6 and 7 per cent through smut. Report superiority of Jensen hot-water treatment over all others for the prevention of the disease, requiring 15 minutes' immersion in water at 132¼° F., but recommend, tentatively, use of potassium sulphide one-half per cent solution, in which seed may be immersed 24 hours. Find various other chemicals while preventing the smut greatly injure the stand. Announce the discovery for the first time of a "hidden smut" which, while not apparent without tearing away the glumes, destroys the grain completely. Conclude seed from clean field will produce a crop free from smut, but if adjoining fields are smutty the oats from a clean field will in a few years become infected with the disease.

292. MAGNUS, P. **Ueber das Auftreten eines Uromyces auf Glycyrrhiza in der alten und in der neuen Welt.** (mit Tafel XX). Berichte der deutschen botanischen Gesellschaft. Band VIII, Heft 10, pp. 377–384, December 30, 1890. Discusses at some length the synonymy of the various species of *Uredineæ* described on *Glycyrrhiza* giving history of each description. Concludes the American species found upon *Glycyrrhiza lepidota* by various authors and variously named, to be identical with that upon *Glycyrrhiza glabra*, L., of the East. Draws the conclusion from the fact that the variation of the species of Glycyrrhiza has become specific and the parasite remained the same; that *Uromyces glycyrrhizæ* was parasitic upon plants of the genus Glycyrrhiza before the separation of North America and Europe in the Tertiary period. "Ich glaube daher nicht zu viel zu behaupten wenn ich sage, dass *Uromyces glycyrrhizæ* ein Parasit ist, den Glycyrrhiza seit den Zeiten bewohnt, da Nordamerika und Europa noch ein einheitliches Florengebiet bildeten." Gives preference to name *Uromyces glycyrrhizæ*, (Rabh.) Magnus, with the following synonymy: *Puccinia glycyrrhizæ*, Rabh., in Klotzsch, Herb. mycologicum, No. 1396. *Uredo leguminosarum*, (Lk.) form *glycyrrhizæ*, Rabh., in Flora, 1850, p. 626. *Uromyces appendiculata*, (Pers.) Rabh., in Isis, 1870, Heft IV, No. 18. *Cæoma* (*Uredo*) *glumarum*, (Desm.) Sorokin, in Materialien sur Flora Mittelasiens (Bull. der Naturforschenden Gesellschaft in Moskau, 1884. *Uromyces trifolii*, (Alb. und Schwein.) Wint., in Ell. & Everhart, N. A. F., 1876. *Uromyces genistæ-tinctoriæ*, (Pers.) Wint., 1887, in Acta Horti. Petoprolitani, vol. X, p. 262.

293. MASSEY, W. F. **Clover and cotton rust.** American Agriculturist, March, 1891, vol. L, No. 3, p. 144, (½ column). Upholds as plausible the theory of practical farmers that cotton rust spreads from clover fields lying adjacent to cotton fields.

294. MAYNARD, S. T. **Fungous pests.** Bull. 13, Mass. Hatch. Ex. Sta., April, 1891, pp. 3–10. Gives names of various fungi causing diseases of orchard, with formulæ for fungicides and outline of treatment of the same.

295. MCCARTHY, GERALD. **Copper salts a possible source of danger.** Agricultural Science, vol. V, No. 6, June, 1891, La Fayette, Ind., pp. 156–158. Gives summary of results of the German scientist, Dr. Haselhoff, read in a paper before

295. McCarthy, Gerald—Continued.
the German Association at Bremen, showing the poisonous effects of copper sulphate. The investigator finds the dry substance of plants grown in soil impregnated with copper sulphate to decrease in proportion to the quantity of that salt present. Expresses the opinion that the formulæ for the Bordeaux mixture may be modified, greatly lessening the amount of copper, and refers to work done at St. Michel Experiment Station and to experiments performed by Quantin, Mason, and others. Reports Bordeaux mixture containing one-fourth to one-eighth the usual amount of copper as giving results equivalent to the regular formula.

296. Morgan, A. P. **North American fungi.** Fourth paper. Read January 6, 1891 (with plates). The Gastromycetes. The Journal of the Cincinnati Society of Natural History, Cincinnati, Ohio, vol. XIV, No. 1, Apr., 1891, pp. 5–21 (a continuation from vol. XII, p. 172, of same journal). Treats of the North American species of *Lycoperdon*, Tourn., giving generic and specific descriptions, with notes upon distribution. Describes as new *L. Peckii*, Morg.; *L. elegans*, Morg.; *L. muscorum*, Morg., and gives careful descriptions of 28 other species with frequent figures. Monographic and of great value to mycologists in the study of this genus.

297. Moseley, Henry C. **The chinch bug cholera.** Farmers' Review, Chicago, Ill., June 3, 1891, vol. XXII, No. 22, p. 255 (1 column). Notes appearance in Illinois of a mold upon chinch bugs and refers to work of Professor Snow on the subject (see 103).

298. Phillips, W. **Omitted Discomycetes.** Grevillea, June, vol. XIX, No. 92, p. 106. Describes *Helotium aurantiacum*, Cke., on underside of decayed leaves. U. S., J. B. Ellis, No. 75. *Lachnella albopileata*, Cke., var. *subaurata*, Ellis, on both sides of leaves of *Clethra alnifolia*, from J. B. Ellis, Newfield, N. J., U. S.

299. Pearson, A. W. **Experiments in treatment of the diseases of plants.** Gard. and Forest, New York, vol. IV, No. 154, Feb. 4, 1891, p. 52. Gives, in brief, results of experiments with copper mixtures. Concludes copper acetate (2½ pounds in 25 gallons of water) as good as Bordeaux mixture for potato blight; iron sulphate ineffectual in treatment of grape diseases. Gives the formula for the mixture of copper carbonate and glue as effective against vine diseases (1 pound copper carbonate, 3 ounces glue, 25 gallons water). Reports failure to control Anthracnose with the copper mixtures.

300. Prentiss, A. N. **History of the current progress of the economic study of plant diseases.** Proc. Western New York Hort. Soc., 36th Ann. Meeting, January 28–29, 1891, Rochester, N. Y., pp. 18–21. Garden and Forest, February 11, 1891, vol. IV, No. 155, p. 71. Outlines history of the study in this country, mentioning the work of Engelmann, Farlow, Burrill, Peck, Arthur, and others, calling attention to the work of the Department of Agriculture and of the Experiment Stations.

301. Scribner, F. L. **Fungous diseases of the grape and other plants** (with numerous figures). 12mo, 134 pp., J. T. Lovett & Co., Little Silver, N. J., 1890 (issued in 1891). The author describes in clear, popular style the various diseases of plants. Gives special attention (92 pages) to the diseases of the grape. The work is especially adapted for the use of vineyardists and fruit-growers and fills a want which is rapidly growing. After a short introductory of what fungi are, the second and third chapters are devoted to black rot of grapes and its treatment. The general characteristics of the malady followed by a description of the parasitic fungus are given, together with an account of experiments made in its treatment. Chapter IV describes bitter rot (*Greeneria fuliginea*) and white rot (*Coniothyrium diplodiella*), with suggestions for treatment as in black rot. Chapter V treats of brown rot (*Peronospora viticola*). Chapter VI, powdery mildew (*Uncinula ampelopsidis*).

301. Scribner, F. L.—Continued.
Chapter vii, grape leaf blight (*Cladosporium viticolum*). Chapter viii, root rot of the vine (*Agaricus melleus* and *Dematophora necatrix*), with figures from Millardet, Hartig, and Viala. Recommends immediate removal of attacked vines, thorough drainage and cleaning of ground of all vegetation for several years, and trenching about affected area for prevention of spread of disease. Chapter ix, Anthracnose and birds'-eye rot (*Sphaceloma ampelinum*). Recommends early washing of canes with 50 per cent solution of iron sulphate or 10 per cent solution of copper sulphate and dusting of vines with sulphur and powdered lime if disease appears during the growing season. Chapter x, dotted or speckled Anthracnose of the vine. Chapter xi, black rot of the apple (*Macrophoma malorum*). Chapter xii, apple rust and cedar apples (*Gymnosporangium macropus*). Recommends removal of cedar trees near orchard, planting of resistant varieties, and spraying with Bordeaux as soon as leaves start. Chapter xiii, apple scab (*Fusicladium dendriticum*). Gives course of treatment, recommending early spring washing with simple solution of copper sulphate (1 pound to 10 gallons of water), together with three early sprayings with the ammoniacal solution or modified eau céleste. Chapter xiv, pear scab (*Fusicladium dendriticum*). Considered by the author as only a form of this species and not specifically distinct. Chapter xv, the Entomosporium of the pear and quince (*Entomosporium maculatum*). Recommends winter treatment with copper sulphate and treatments during the growing season with Bordeaux mixture. Chapter xvi, plum rot or the Monilia of fruit (*Monilia fructigena*). Recommends clean culture and a trial of the ammoniacal solution of copper carbonate as preventive. Chapter xvii, black knot of the plum and cherry. Recommends usual method of removal of infected parts and disinfection with Bordeaux mixture. Thinks disease a fit subject for legislation. Chapter xviii, leaf-spot disease of the plum and cherry (*Septoria cerasina*). Chapter xix, powdery mildew of the cherry (*Podosphæra oxyacanthæ*). Recommends use of flowers of sulphur and potassium sulphide ($\frac{1}{2}$ ounce per gallon of water). Chapter xx, peach leaf curl (*Taphrina deformans*). Chapter xxi, the fungus of the raspberry Anthracnose. Recommends winter wash for canes 50 per cent solution of iron sulphate and applications of sulphur and powdered lime in equal parts.

302. ———. **Powders for combating the fungous or cryptogamic diseases of plants.** Rural New Yorker, June 13, 1891, vol. l, No. 2159, p. 453. Discusses various powders used as fungicides, recommending two for further trial, viz, sulphatine and sulpho-steatite. Refers to Circular 5 of Division of Vegetable Pathology, U. S. Dept. of Agr.

303. ———. **Leaf-spot of the India-rubber tree** (*Leptostromella elastica*, Ellis & Scribner) with figs. Orchard and Garden, Little Silver, N. J., January, 1891, vol. xiii, No. 1, p. 6. Ascribes cause of the disease of *Ficus elastica* to a new species of *Leptostromella* described by Ellis & Scribner.

304. ———. **Leaf-spot of screw palm** (*Physalospora pandani*, Ellis & Scribner) with figs. Orchard and Garden, Little Silver, N. J., January, 1891, vol. xiii, No. 1, p. 6. Describes the disease common upon leaves of screw palm found at Knoxville, Tenn., as caused by a new species of *Physalospora* described elsewhere.

305. ———. **Plum leaf of shot-hole fungus** (with figs.). Canadian Horticulturist, Grimsby, Ontario, November, 1890, vol. xiii, No. 11, pp. 315–316. Reproduction of article in Orchard and Garden, giving short account of the disease.

306. ———. **Black knot of the plum and cherry** (with plate). Bull. Tenn. Agr. Ex. Sta., vol. iv, No. 1, January, 1891, pp. 26–28, Knoxville, Tenn. Describes disease and shows necessity of concerted action in stamping out the parasite.

307. Smith, Erwin F. **Peach yellows.** Synopsis of an address at Easton, Md., January 22, 1891. Reprint from Proceedings of Peninsula Hort. Soc., p. 8.

307. SMITH, ERWIN F.—Continued.
Gives figures showing great increase of the disease in ten representative orchards in the upper part of Delaware and Chesapeake peninsula from 1887 to 1890. Reports results of inoculation experiments by budding healthy trees with diseased buds, showing the contagious nature of the malady. (These results are to be published in Bulletin No. 1 of the Division.) Answers numerous inquiries in regard to the eradication of the disease, deciding that concerted action in the matter of removal of diseased material is the best means known for the prevention of spread of the malady. States that fertilizers have been of no advantage whatever in experiments of the past three years.

308. SOUTHWORTH, EFFIE A. **A new hollyhock disease** (with fig. copied). Popular Gardening, December, 1890, vol. VI, No. 3, pp. 56–57. Reprint of figures and abstract of article in Journal of Mycology, vol. VI, No. 3.

309. SWINGLE, W. T. **First addition to the list of Kansas Peronosporaceæ.** Extract from Trans. 22d and 23d Ann. Meetings, Kansas Acad. Sci., vol. XII, Topeka, Kans., pp. 129–134 (March 30, 1891). Gives corrections and additions to original list (see THIS JOURNAL, vol. 6, No. 1, p. 41), reporting *Acnida tuberculata* as new host in the State for *Cystopus amaranti*, (S.) Berkeley, *Bidens chrysanthemoides*, Mich. as new host for *Plasmopara Halstedii*, (Farlow) Berlese and De Toni., and *Peronospora calotheca*, DBy. as a species new to the State, growing on *Galium aparine*. Notes ability of *Peronospora euphorbiæ* to withstand drought and habit of *Peronosporaceæ* in general to confine their attacks in dry weather to their commoner host plants. Reports from State, including this additional list, 33 species on 71 different hosts.

310. THAXTER, ROLAND. **The Connecticut species of Gymnosporangium** (Cedar Apples). Bull. No. 107, Conn. Ag. Exp. Sta., New Haven, Conn. (Distributed April 15, 1891.) Reports seven distinct species for the State, two upon *Cupressus thyoides*, one on *Juniperus communis*, three upon *J. Virginiana*, and one upon both *J. communis* and *J. Virginiana*. Records successful establishment of connection of *Gymnosporangium* with its proper rust in all cases but that of *G. Ellisii*, and describes as new species discovered by cultures *Gymnosporangium nidus-avis*, Thaxter on *Juniperus Virginiana*, with *Rœstelia* stage upon *Cydonia* (quince) and *Amelanchier Canadensis*.

311. ———. **The potato scab** (with plate). Report of Mycologist in 14th Ann. Rep. Conn. Ag. Ex. Sta., 1890 (1891), pp. 3–17. Discusses fully the various theories proposed to account for the disease, deciding Bruncharst's *Skurv* as specially distinct from American scab. Gives general characteristics of the disease, with account of the invariable presence when properly examined of an extremely minute fungus, resembling, with exception of its true branching fructification, some of the polymorphic bacteria. Records the entirely successful cultivation of the fungus upon various media and the life history as far as understood. Describes most striking series of successful inoculations of healthy tubers with pure cultures and with the fungus freshly removed from diseased potatoes. Inclines to the opinion that there are two species of scab, which may explain differences in results obtained by Mr. Bolley and the author (see Nos. 120–121).

312. ———. **Diseases of tomatoes.** *Ibid.*, p. 17. Reports *Phytophthora infestans*, DBy. *Cladosporium fulvum*, Cke., *Macrosporium tomato*, Cke., and *Fusarium lycopersici*, Sacc., as causing damage in the State of Connecticut.

313. ———. **Fungous diseases of tomato worms.** *Ibid.*, p. 18. Notes presence for the first time observed, of species of *Empusa* upon larva of the *Sphingidæ* and the occurrence of *Empusa grylli*, form *aulicæ*, on *Phlegethontius Carolina* and *P. celeus*.

314. ———. **Fungous diseases of grape-leaf hopper and cabbage worms.** *Ibid.*, p. 19. Reports species of *Empusa* upon grape-leaf hoppers (*Tettigonia vitis*) as also liv-

314. Thaxter, Roland—Continued.
ing upon the cabbage worm (*Pieris rapæ*). Gives results of simple experiment which showed the identity of the two diseases as being caused by the same species of *Empusa*.

315. ———. **Peronospora on cucumbers.** (*P. Cubensis*, B. & C.) *Ibid.*, p. 19. Reports occurrence at South Manchester, Conn.

316. ———. **Mildew of Lima beans.** *Ibid.*, p. 19. Reports extension of *Phytophthora phaseoli*, Thax., from New Haven to Hartford and west to Norwalk. Does not find it outside of State.

317. ———. **Rust of pears.** *Ibid.*, p. 20. Shows presence of *Ræstelia* stage of *Gymnosporangium globosum* upon pears of the Japanese strain.

318. ———. **Mildew of buckwheat.** *Ibid.*, p. 20. Reports *Ramularia rufo-maculans* on buckwheat.

319. ———. **Rye rust and smut.** (*Puccinia rubigo-vera*, (DC.) Wint, and *Urocystis occulta*, Rabh.) Reports as unusually abundant.

320. ———. **Some results from the application of fungicides.** (Leaf spot of quince, with plate, *Entomosporium maculatum*). *Ibid.*, pp. 21, 22. Reports successful use of Bordeaux mixture and ammoniacal solution of copper carbonate against disease, with preference for the Bordeaux.

321. ———. **Black rot of grapes.** Records success in treatment of disease with Bordeaux and copper carbonate in ammonia.

322. ———. **Leaf spot of plums and cherries causing defoliation.** *Ibid.*, p. 24. Records successful use of Bordeaux mixture in prevention of the disease, trees sprayed holding their leaves intact, while those unsprayed dropped their leaves in July.

323. ———. **Potato blight.** *Ibid.*, p. 24. Reports successful checking of disease by the use of Bordeaux, giving comparison of 3¾ bushels per row as compared with 6 bushels sprayed. Only 5 rows were treated.

324. ———. **Strawberry rust.** *Ibid.*, p. 24. Records negative experiment with fungicides in its prevention.

325. ———. **Further experiments on the "smut of onion."** Continues last year's experiments and reports the flowers of sulphur sown with the seed as giving results in the ratio of 5 to 1. In a large experiment finds sulphide of calcium, muriate of potash, muriate of lime, and hyposulphite of sodium of little value, while sulphide of potassium and flowers of sulphur gave moderate results. Finds from greenhouse cultures that the first leaves of seedlings are susceptible to infection by germinating smut spores while being pushed through the ground.

326. ———. **Fungicides and their application** (with fig.). *Ibid.*, pp. 26–35. Discusses methods of application, pumps, hose, nozzles, describing a convenient pump to be used with a copper tank shaped like a washboiler. Gives formulas of Bordeaux, copper carbonate, ammoniacal copper carbonate and ammonia-copper solutions made by mixing copper sulphate and ammonium carbonate together in proportions of ½ pound of copper sulphate to 1 pound ammonium carbonate.

327. Weed, C. M. **Preventing downy mildew or brown rot of grapes** (with figs.). Bull. Ohio Ag. Ex. Sta., vol. III, No. 10, November, 1890 (issued 1891). Columbus, Ohio. Reports results of experiments in Ohio with these diseases, showing pronounced success with eau celeste and total failure with iron sulphate (copperas). Concludes eau celeste superior as preventive to ammoniacal copper carbonate.

328. Woodworth, C. W. **Botanical notes.** Second Ann. Rept. Ark. Ag. Ex. Sta., 1889 (published 1890), pp. 191–193. Describes in a popular way, giving remedies, pear blight, grape mildew, black rot of the grape, and sorghum blight. Claims to have discovered *Bacillus sorghi*, Burrill, while studying under Professor Burrill. Gives formulas for fungicides.

329. YEOMANS, W. H. **Bean rust and other fungous diseases.** Popular Gardening, November, 1890, vol. 6, No. 2, p. 27 (½ column). Popular description of diseases.

330. ZABRISKIE, J. L. **The fungus Pestalozzia insidens,** n. s. (with plate). Journal N. Y. Mic. Soc., July, 1891, vol. VII, No. 3, pp. 101–102. Describes the species as new on bark of living trees of *Ulmus Americana*. Collected near Baltimore, Md.